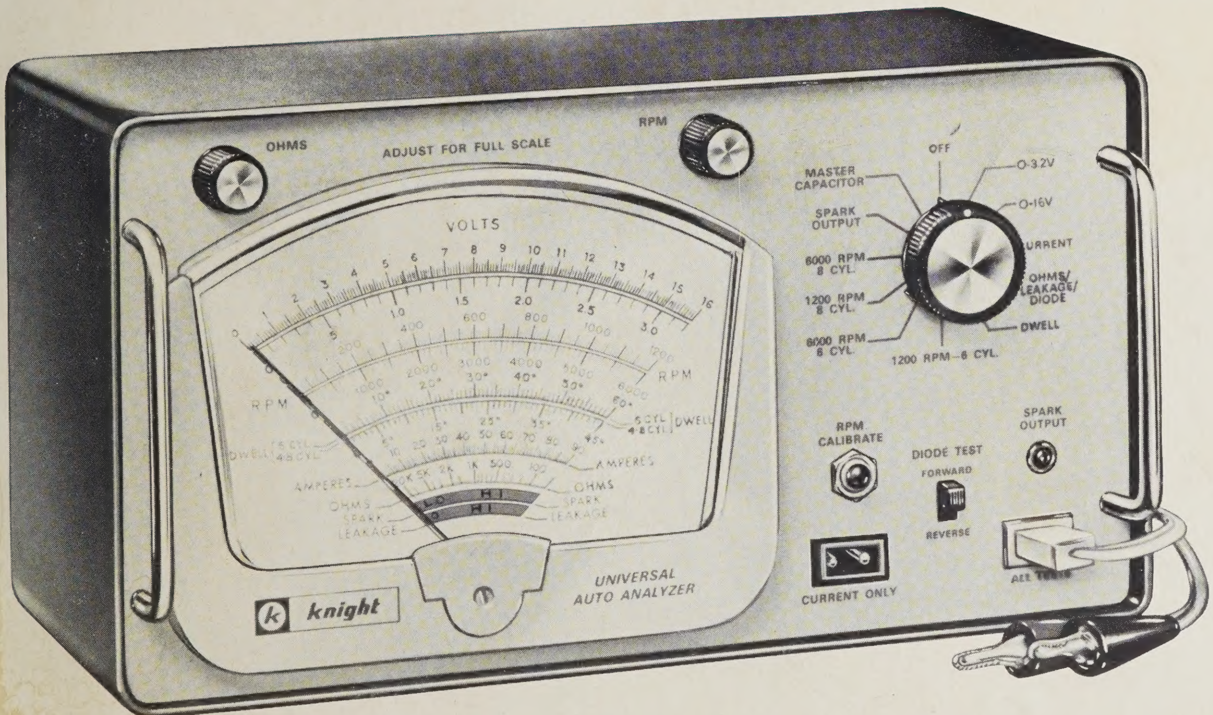
knight-kit® ASSEMBLY MANUAL



KG-375 UNIVERSAL AUTO ANALYZER

Thank You . . .

for your interest in Knight-Kits.

This Assembly Manual represents our many decades of experience in developing electronic kits which bring you outstanding performance at dollar-saving prices . . . and with maximum ease of construction.

As you go through the pages of this brochure, note how carefully each stage of construction is explained—how each diagram is magnified so that you almost have the feeling a good instructor is working at your side!

Knight-Kit's "do and check" method of kit-building insures accurate and simple assembly. Although your final product may represent a very complicated piece of electronic equipment, you will proceed with ease and assurance, step-by-step . . . and enjoy enormous satisfaction in your completed working unit.

We know you will find the building of this Knight-Kit a most rewarding experience.

MODEL KG-375
UNIVERSAL AUTO ANALYZER

save costly repair bills — improve your car's performance and overall efficiency

- Use for Tune-Ups—Checks Generator, Alternator, Regulator, Wiring
- Analyzes Both 6 and 12-Volt Systems; 4, 6, or 8 Cylinder Engines
- All Solid-State Circuitry for Reliability and Minimum Current Drain

The KG-375 Universal Auto Analyzer makes tune-ups and trouble-shooting fast and easy. No more costly minor repair bills or long waiting periods for your car when you use this portable, all-in-one compact unit. Self-powered, you can take the KG-375 with you in your car and perform actual road tests. Use the electronic tachometer to show engine speed—check idle speed and automatic shift points. Dwell angle scales check distributor operation and automatic spark advance. Other scales let you measure generator output voltage and current; check operation of voltage regulator; locate faulty distributor points, bad sparkplugs, defective spark coils.

You can check charge and discharge capacity of batteries; perform forward and reverse tests on alternator diodes; and test all wiring and electrical accessories. The KG-375 is housed in a rugged steel case for protection, and the handy roll bars make it easy to put the analyzer wherever you want it. A comprehensive tune-up and trouble-shooting procedure is included. The KG-375 is for both 6 or 12 volt systems, negative or positive grounded types.

THIS KIT MUST BE PROPERLY SOLDERED!

USE ENOUGH HEAT

This is the main idea of good soldering. Apply enough heat to the metal surfaces you are joining to make the solder spread freely, until the contour (shape) of the connection shows under the solder.

AN ELECTRONIC UNIT WILL NOT WORK . . . unless it is properly soldered. Read these instructions carefully to understand the basic ideas of good soldering.

Enough heat must be used so the solder can actually penetrate the metal surfaces, making an unbroken path over which electricity can travel. You are not using enough heat if the solder barely melts and forms a rounded ball of rough, flaky solder.

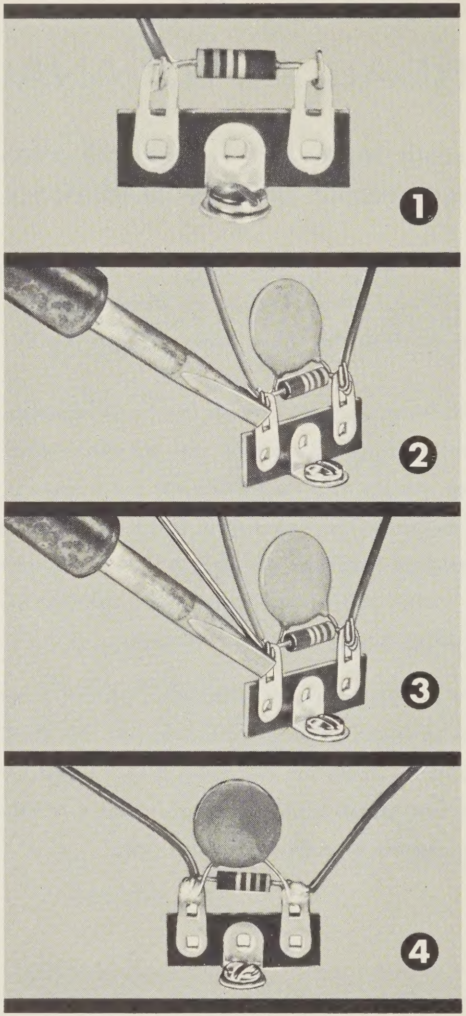
Use the Right Soldering Tool

A soldering iron in the 27-40 watt range is recommended. Any iron in this range with a clean, chisel-shaped tip will supply the correct amount of heat to make a good solder connection. You may also use a solder gun but make sure the tip reaches full heat before you solder.

Keep the iron or gun tip brightly coated with solder. When necessary, wipe the hot tip clean with a cloth. If you are using an old tip, clean it before you start soldering.

Use Only Rosin Core Solder

We supply the right kind of solder (*rosin core solder*). Do not use any other kind of solder! **Use of Acid Core Solder, Paste, or Irons Cleaned on a Sal Ammoniac Block will ruin any Electronic Unit and will Void the Guarantee.**



HERE'S HOW TO DO IT . . .

1. Join bare metal to bare metal; insulation must be removed. Make good mechanical connections and keep resistor and capacitor leads as short as possible, unless otherwise specified.

2. Coat the tip of a hot iron with solder. Then **Firmly Press the Flat Side of the Tip** against the parts to be soldered together. Keep the iron there while you . . .

3. Apply the solder between the metal to be soldered and the iron tip. Use only enough solder to flow over all surfaces of the connection, and all wires in the connection. Remove the iron.

Do Not Move Parts Until the Solder Hardens. If you accidentally move the wires as the solder is hardening, apply your iron and reheat.

4. Compare your soldering with the pictures on this page. You have a good connection if your solder has flowed over all surfaces to be connected, following the shape of the surfaces. It should appear smooth and bright and all wires in the connection should be well-soldered.

You Have Not Used Enough Heat: If your connection is rough and flaky-looking, or if the solder has formed a round ball instead of spreading.

The difference between good soldering (enough heat) and poor soldering (not enough heat) is just a few extra seconds with a hot iron **firmly** applied. **REMEMBER, LARGER METAL SURFACES TAKE A LONGER TIME TO HEAT.**

CONSTRUCTION HINTS

Your auto analyzer is capable of excellent performance *when built carefully*. Please follow the instructions carefully and work slowly. Kit building is a very pleasurable experience, and should be fully enjoyed.

A few pointers may help you as you prepare to assemble the Analyzer.

Proper soldering is the most important phase of construction so we suggest that you spend some time studying the instructions given further on in the manual. Soldering is very simple. Do not be afraid of it.

Recheck your work frequently — a good rule of thumb is to go back over your work at the end of each page.

UNPACKING

This step is important, because it gives you a chance to become familiar with the parts used in your kit.

☐ Check the contents of your kit against the PARTS LIST. Use the parts identification chart for any parts you do not recognize.

☐ Assort hardware by size. The hardware identification photograph is shown actual size. A plastic ice-cube tray or baking pan with small compartments is very handy for keeping the small parts and hardware separate, and will prevent misplacement.

☐ Leave the large components in their protective cartons until needed. This will protect them from damage, and avoid the possible loss of mounting hardware.

WIRING HINTS

The step-by-step instructions must be followed exactly. Do not attempt to wire your kit from the pictorials or schematic diagram only. As you complete each step, it is a good idea to check it off in the box provided. This will enable you to stop at any point and return to the same point at another time without overlooking a step.

You will need a screwdriver, longnose pliers, soldering iron with a small tip, and a pair of wire cutters for construction of this kit.

As you wire, make good mechanical connections before soldering. Loop wires and leads of components around terminals, and clamp tightly with your pliers. Be sure to clip off all excess lead lengths. Cut off any excess leads after soldering has been completed.

The completed solder connection should have a shiny, metallic finish; if it is not shiny, reheat it slightly, adding a little solder.

The wire supplied with your kit is precut and pre-stripped. Be sure to use the specified color. Flexible tubing is provided to cover bare wires and leads when there is a probability that a bare lead might touch nearby leads or the chassis.

Remember to take your time and work slowly. Your efforts will be rewarded with a fine electronic instrument.

PARTS MOUNTING ON THE CHASSIS

SEE FIGURE 1

- [x] Position the chassis as shown in the figure.
- [x] TR-1, TR-2, and TR-3, three transistor sockets. Mount the sockets with the terminals positioned up as shown. Fasten each socket with two 2-56 screws and nuts.
- [ ] The following controls are identical and are mounted by inserting the tabs into the slots on the side of the chassis. Fasten the controls by twisting the tabs ¼ turn. When mounting be sure the terminals are positioned up as shown.
    - [x] R-23, 150 Ω control.
    - [x] R-20, 150 Ω control.
    - [x] R-24, 150 Ω control.
    - [x] R-22, 150 Ω control.
- [x] Large grommet. Insert in the hole in the side of the chassis.
- [x] Two small grommets. Insert in the holes shown.

NOTE: The following parts are mounted with the binder head screws. Use the 6-32 flat-head screws only where specified.

- [x] Three large terminal strips for TS-1, TS-2, and TS-3. Position each with the mounting feet as shown. Mount each with two 6-32 screws, lockwashers and nuts. When mounting parts, unless otherwise specified, the lockwasher goes between the nut and the part.

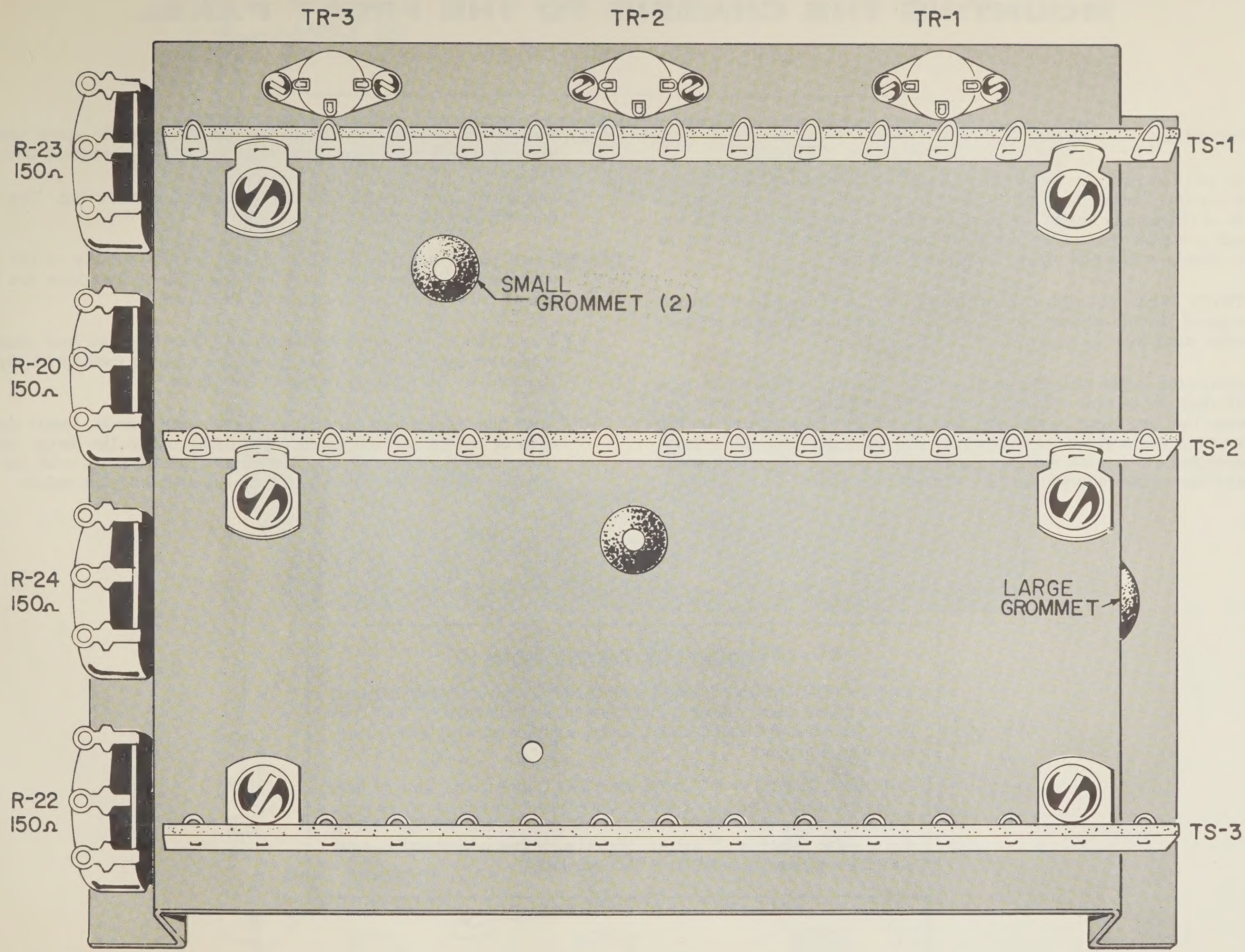


FIGURE 1. PARTS MOUNTING ON THE CHASSIS

MOUNTING THE CHASSIS TO THE FRONT PANEL

SEE FIGURE 2

☑ C-3, large capacitor. Twist the red and black leads of this capacitor together. Insert these two leads through the large grommet in the side of the chassis. Insert the yellow lead of the capacitor through the small grommet nearest the transistor sockets. Mount the capacitor to the chassis with a 6-32 screw, lockwasher and nut.

CAUTION: When mounting the solder lugs to the meter and the meter to the panel, do not overtighten the nuts. If too much pressure is used, the meter studs may be loosened.

☑ Remove the meter from the carton. Place the meter face down on a soft cloth to prevent scratching. Remove the jumper wire from between the two meter terminals. Mount the two solder lugs to the meter terminals with four flatwashers and two nuts. The solder lugs, flatwashers, and nuts are supplied with the meter. The four small lockwashers and nuts will be used to mount the meter to the panel.

☑ Yellow wire. Solder one end to the solder lug on the meter terminal marked with a (+) plus. The other end will be connected later.

☑ Green wire. Solder one end to the remaining solder lug. The other end will be connected later.

☑ Front panel and two handles. Mount the two handles to the panel with four 6-32 screws and lockwashers. The lockwashers are to be placed between the screw head and the panel.

☑ Mount the meter to the front panel by inserting the four mounting studs through the holes in the panel. Position the meter with the plus terminal to the right as shown in the figure.

☑ Place the chassis over the four meter mounting studs. Insert the free ends of the yellow and green wires connected to the meter through the grommet shown. Fasten the chassis to the panel with the four external tooth lockwashers and nuts supplied with the meter.

IMPORTANT INSTRUCTIONS

THE INSTRUCTION CONNECT MEANS: Connect the wire or lead to the given point. Make a firm mechanical connection, **BUT DO NOT SOLDER AT THIS TIME.** Later another wire(s) will be connected to this point.

THE INSTRUCTION SOLDER MEANS: Connect the wire or lead to the given point and then solder the connection and all wires in it. If there is more than one wire in the connection, the number will be stated—for example (2 wires). After soldering a connection, trim all wires as close as possible to the terminals.

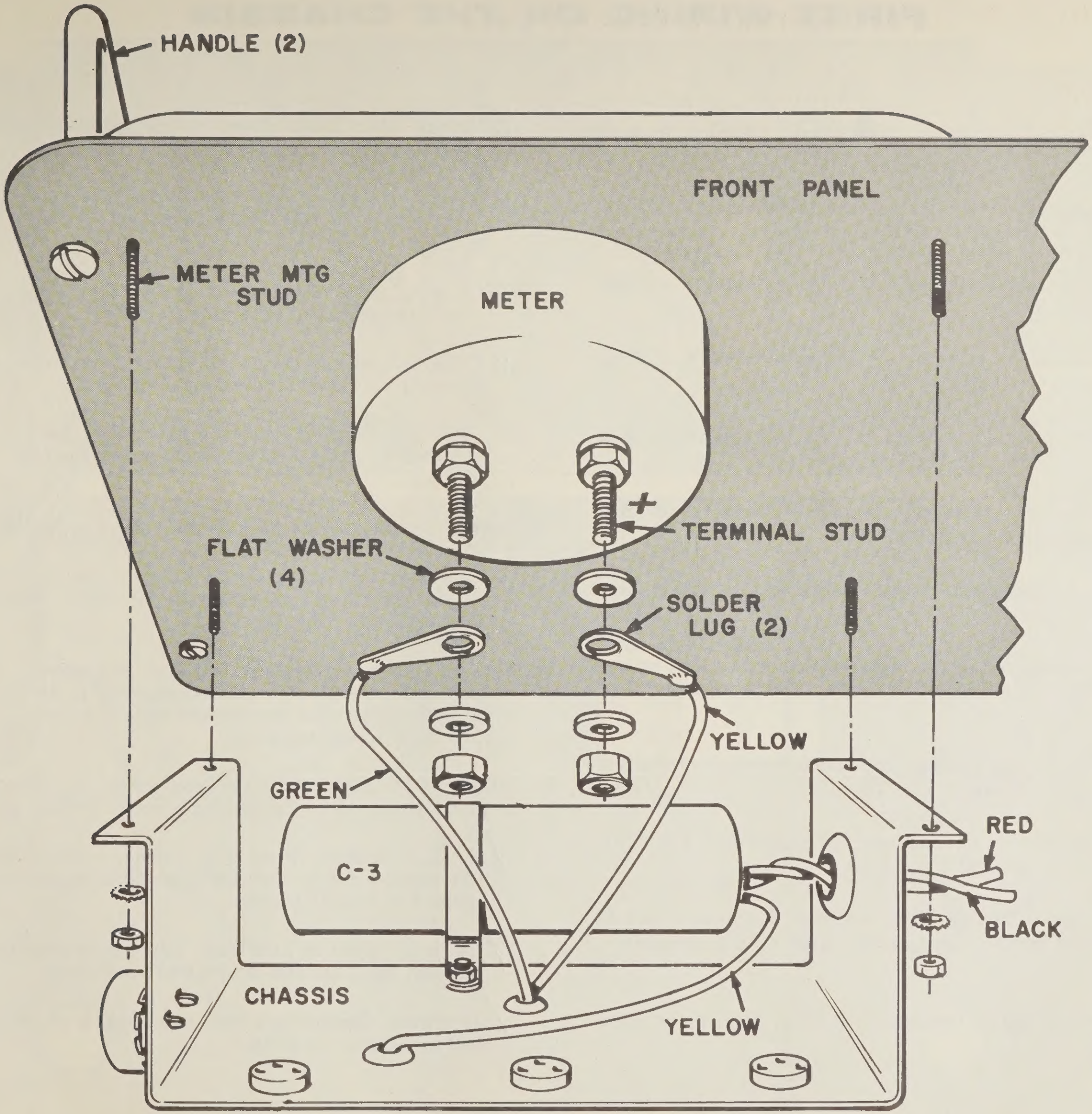


FIGURE 2. MOUNTING THE CHASSIS TO THE DRESS PANEL

FIRST WIRING ON THE CHASSIS

SEE FIGURE 3

NOTE: Cut bare wire from the long length supplied, as needed for each step.

- [x] Cut a 1″ piece of bare wire. Connect one end to terminal 1 of TS-1. Solder the other end to terminal 3 of TR-3.

- [x] Red wire. Connect one end to terminal 5 of TS-1. Solder the other end to terminal 2 of TR-3.

- [x] Cut a 1″ piece of bare wire. Connect one end to terminal 4 of TS-1. Solder the other end to terminal 1 of TR-3.

- [x] Yellow wire from the grommet. Connect the free end to terminal 4 of TS-1.

- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 5 of TS-1. Solder the other end to terminal 3 of TR-2.

NOTE: Resistors may be identified by color bands or have their value stamped on the body.

- [x] R-16, 1.5K (brown, green, red, gold) resistor. Solder one lead to terminal 5 of TS-1 (3 wires). Connect the other lead to terminal 5 of TS-2.

- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 6 of TS-1. Connect the other end to terminal 7 of TS-1.

- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 7 of TS-1. Solder the other end to terminal 2 of TR-2.

- [x] R-15, 15K (brown, green, orange, gold) resistor. Solder one lead to terminal 6 of TS-1 (2 wires). Connect the other lead to terminal 6 of TS-2.

- [x] Red wire. Connect one end to terminal 8 of TS-1. Solder the other end to terminal 3 of TR-1.

- [x] Orange wire. Connect one end to terminal 12 of TS-1. Solder the other end to terminal 1 of TR-2.

- [x] Cut a 1½″ piece of bare wire. Connect one end to terminal 9 of TS-1. Insert the other end through terminal 10 and connect to terminal 11 of TS-1.

- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 11 of TS-1. Solder the other end to terminal 2 of TR-1.

- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 12 of TS-1. Solder the other end to terminal 1 of TR-1.

- [x] R-11, 15K (brown, green, orange, gold) resistor. Solder one lead to terminal 11 of TS-1 (3 wires). Connect the other lead to terminal 11 of TS-2.

NOTE: The capacitors may be marked μf or MF for microfarad.

- [x] C-1, .1 μf tubular capacitor. Connect the lead from the banded end of the capacitor to terminal 10 of TS-2. Solder the other lead to terminal 10 of TS-1 (2 wires).

NOTE: Diodes are polarized and must be connected with the marked end exactly as instructed. For you convenience, these diodes are packaged on a card which specifies the marked end. The marked end is the end with the red band around the diode.

NOTE: Cut tubing from the long length of black tubing supplied, as needed for each step. The red tubing is to be used only where specified.

- [x] CR-3, glass diode. Place a ½″ piece of tubing over each lead. Connect the **marked** end to terminal 9 of TS-2. Solder the other lead to terminal 9 of TS-1 (2 wires).

- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 9 of TS-2. Connect the other end to terminal 10 of TS-2.

- [x] Red wire. Connect one end to terminal 9 of TS-2. Connect the other end to terminal 12 of TS-2.

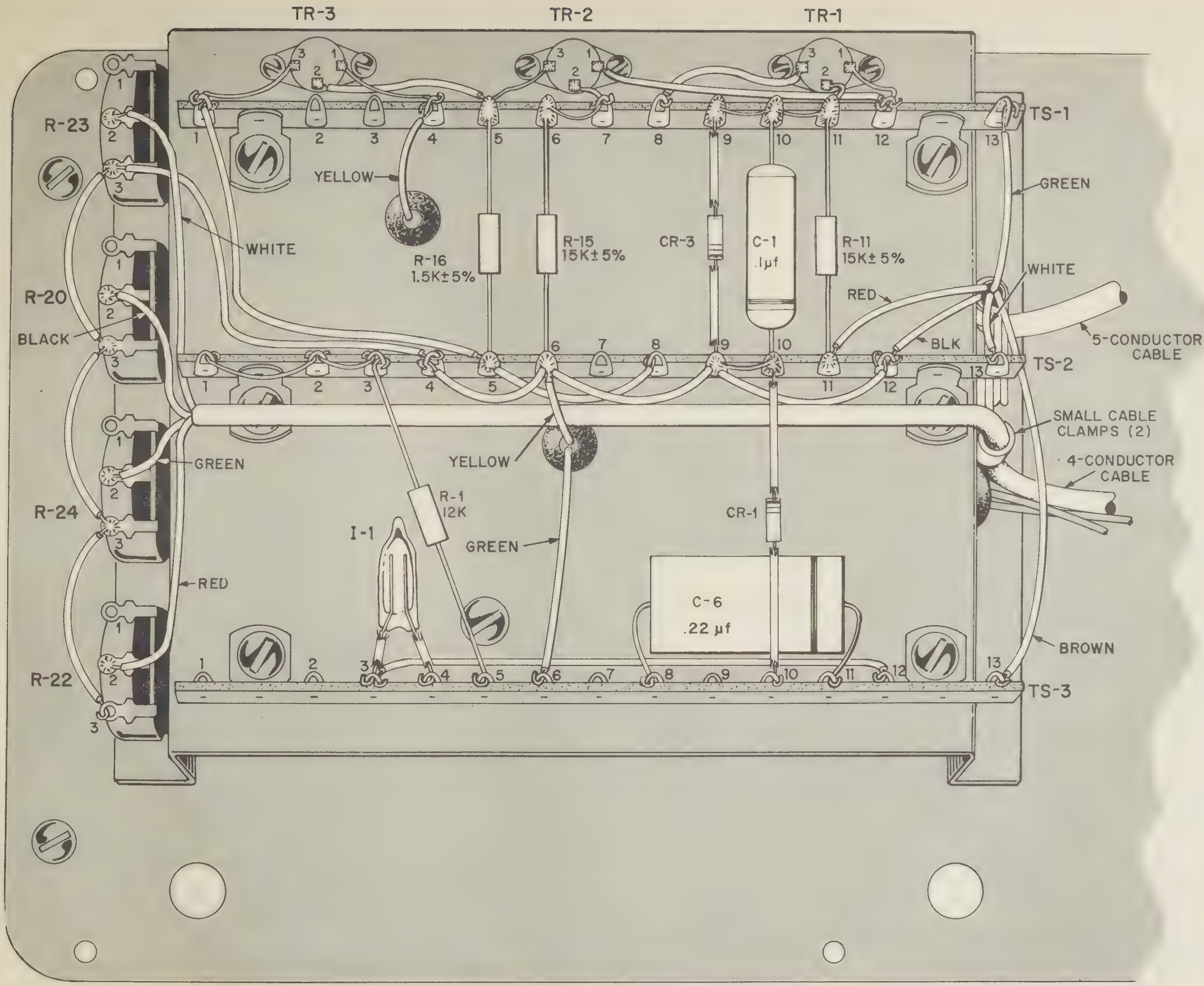


FIGURE 3. FIRST WIRING ON THE CHASSIS

- [x] Red wire. Solder one end to terminal 9 of TS-2 (4 wires). Connect the other end to terminal 6 of TS-2.

- [x] Red wire. Connect one end to terminal 8 of TS-2. Connect the other end to terminal 5 of TS-2.

- [x] Red wire. Connect one end to terminal 6 of TS-2. Connect the other end to terminal 4 of TS-2.

- [x] Yellow wire from the grommet. Solder the free end to terminal 6 of TS-2 (4 wires).

- [x] Green wire from the grommet. Connect the free end to terminal 6 of TS-3.

- [x] Yellow wire. Solder one end to terminal 5 of TS-2 (3 wires). Connect the other end to terminal 1 of TS-1.

- [x] Yellow wire. Connect one end to terminal 4 of TS-2. Connect the other end to terminal 3 of R-23.

- [x] Cut a 3/4″ piece of bare wire. Connect one end to terminal 3 of TS-2. Connect the other end to terminal 2 of TS-2.

- [x] Cut a 1″ piece of bare wire. Connect one end to terminal 2 of TS-2. Connect the other end to terminal 1 of TS-2.

- [x] Red wire. Solder one end to terminal 3 of R-23 (2 wires). Connect the other end to terminal 3 of R-20.

- [x] Red wire. Solder one end to terminal 3 of R-20 (2 wires). Connect the other end to terminal 3 of R-24.

- [x] Red wire. Solder one end to terminal 3 of R-24 (2 wires). Connect the other end to terminal 3 of R-22.

- [x] Green wire. Connect one end to terminal 3 of TS-3. Connect the other end to terminal 12 of TS-3.

NOTE: There are two bulbs used in this kit. I-1 is the unmarked one. I-2 is the bulb marked with a white dot by one lead.

- [x] I-1, the unmarked bulb. Place a 1/2″ piece of tubing over each lead. Connect one lead to terminal 3 of TS-3. Connect the other lead to terminal 4 of TS-3.

- [x] R-1, 12K (brown, red, orange) resistor. Connect one lead to terminal 5 of TS-3. Connect the other lead to terminal 3 of TS-2.

- [x] C-6, .22 μf tubular capacitor. Connect the end marked with a line to terminal 11 of TS-3. Connect the other lead to terminal 8 of TS-3.

- [x] CR-1, glass diode. Place a 3/4″ piece of tubing over each lead. Solder the marked end of the diode to terminal 10 of TS-2 (3 wires). Connect the other lead to terminal 10 of TS-3.

PREPARATION OF THE 4-CONDUCTOR CABLE

SEE FIGURES 4 and 5

- [x] Remove 2 1/2″ of the cable jacket from one end and 1 1/2″ from the other as shown in Figure 4. Do not press down too hard with the knife or you may cut through the inner conductors.

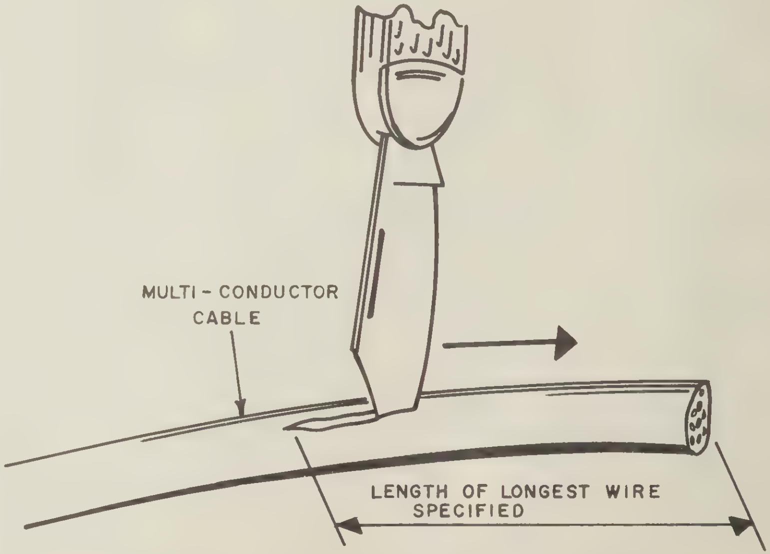


FIGURE 4. CUTTING THE CABLE JACKET

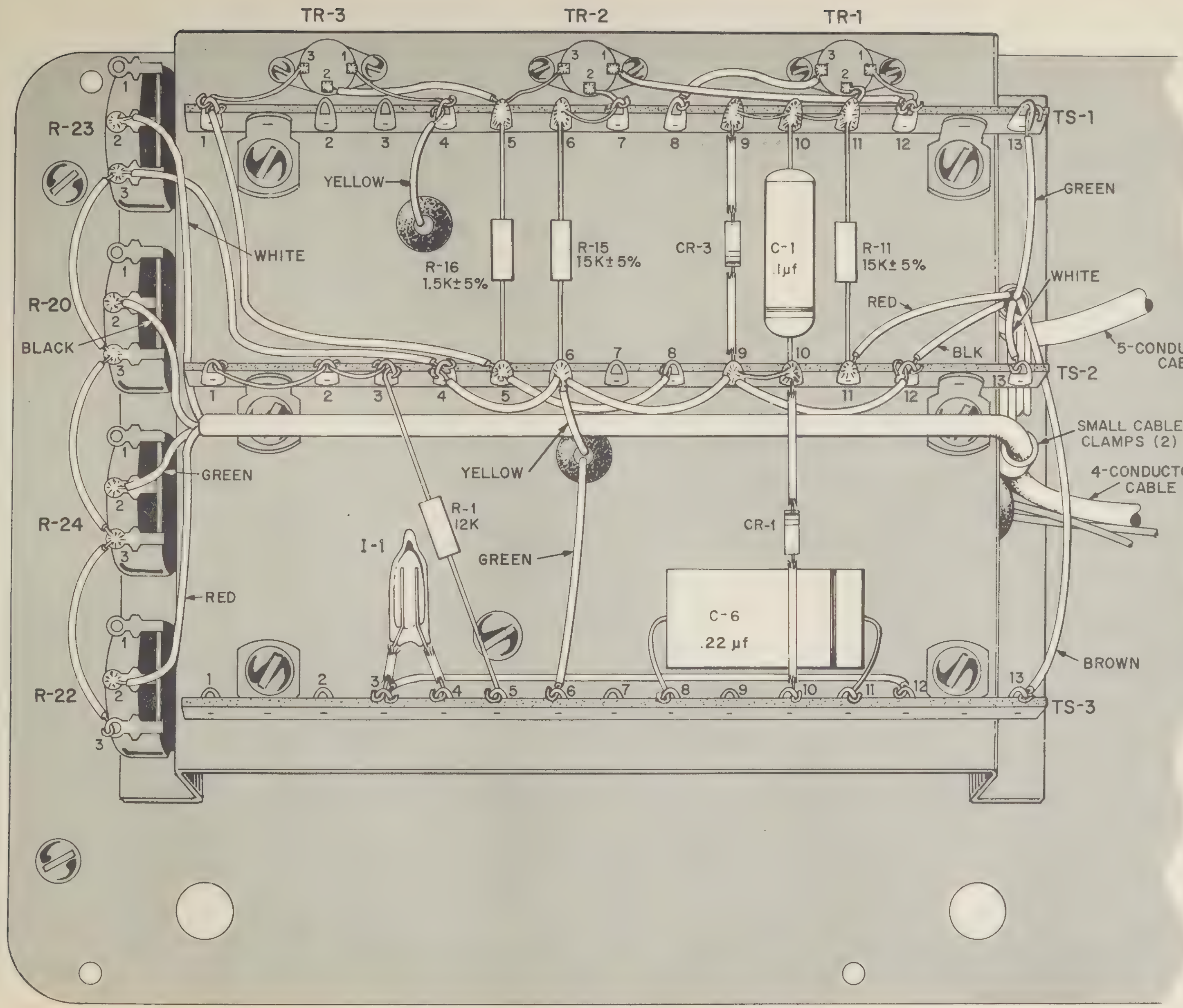


FIGURE 3. FIRST WIRING ON THE CHASSIS

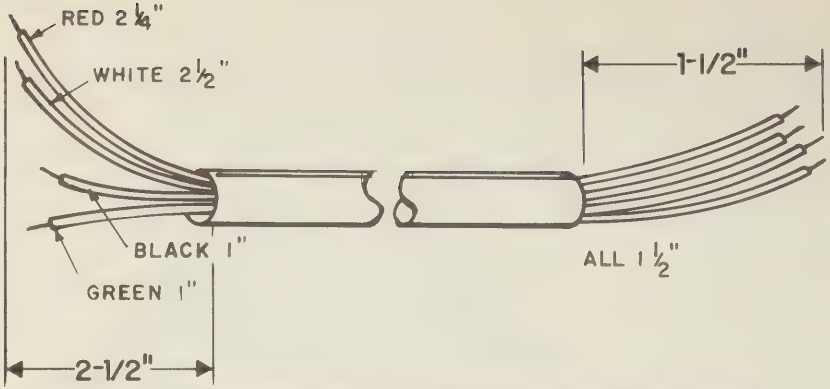


FIGURE 5. PREPARATION OF THE 4-CONDUCTOR CABLE

☐ Cut each of the inner conductors to the length specified in Figure 5. Remove ¼″ of the insulation from each of the conductors. Twist the stranded ends of these conductors and coat lightly with solder.

☐ Connect the end of the cable with the two short leads as follows: The other end of the cable will be connected later.

☐ White lead. Solder to terminal 2 of R-23.

☐ Black lead. Solder to terminal 2 of R-20.

☐ Green lead. Solder to terminal 2 of R-24.

☐ Red lead. Solder to terminal 2 of R-22.

☐ 5-conductor cable. Remove 4″ of the jacket from one end of the cable and 3″ from the other. Prepare the cable as shown in Figure 6.

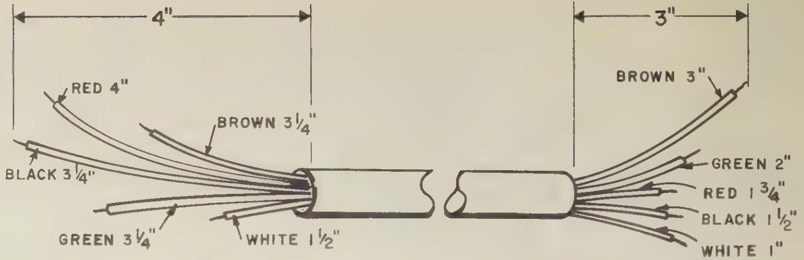


FIGURE 6. PREPARATION OF THE 5-CONDUCTOR CABLE

☐ Connect the end of the cable with the short red lead as follows: The other end of the cable will be connected later.

☐ Red lead. Solder to terminal 11 of TS-2 (2 wires).

☐ Black lead. Connect to terminal 12 of TS-2.

☐ Green lead. Connect to terminal 13 of TS-1.

☐ White lead. Connect to terminal 13 of TS-2.

☐ Brown lead. Connect to terminal 13 of TS-3.

☐ There are four cable clamps used in this kit; two are smaller than the others. Place a **small** cable clamp over each of the two cables just connected. Mount these clamps to the side of the chassis with one of the large thread-cutting screws.

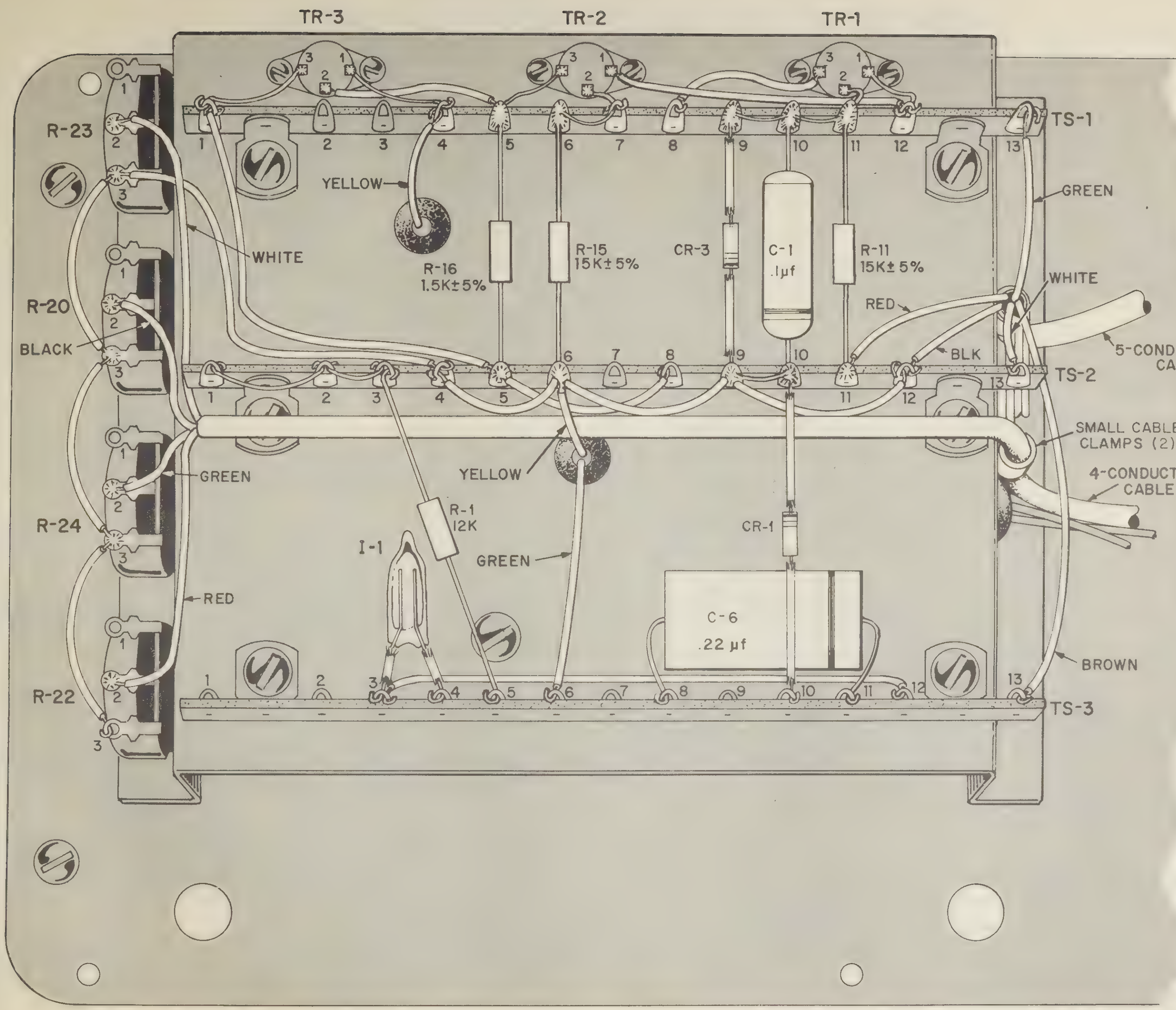


FIGURE 3. FIRST WIRING ON THE CHASSIS

SECOND WIRING ON THE CHASSIS

SEE FIGURE 7

- [x] C-2, 100 μf electrolytic capacitor. Connect the lead from the end marked with a (+) plus to terminal 4 of TS-2. Solder the other lead to terminal 1 of TS-1 (3 wires).

- [x] R-17, 150Ω (brown, green, brown, gold) resistor. Solder one lead to terminal 4 of TS-2 (4 wires). Solder the other lead to terminal 4 of TS-1 (3 wires).

- [x] R-14, 22K (red, red, orange, gold) resistor. Connect one lead to terminal 7 of TS-2. Solder the other lead to terminal 7 of TS-1 (3 wires).

- [x] Cut a 2½″ piece of bare wire. Solder one end to terminal 7 of TS-2 (2 wires). Connect the other end to terminal 8 of TS-1.

- [x] R-12, 1.5K (brown, green, red, gold) resistor. Solder one lead to terminal 8 of TS-1 (3 wires). Connect the other lead to terminal 8 of TS-2.

- [x] R-13, 100Ω (brown, black, brown, gold) resistor. Solder one lead to terminal 12 of TS-1 (3 wires). Solder the other lead to terminal 12 of TS-2 (3 wires).

- [x] R-3, 30.9K, 1% resistor. Solder one lead to terminal 13 of TS-1 (2 wires). Connect the other lead to terminal 13 of TS-2.

- [x] R-2, 5.3K, 1% resistor. Connect one lead to terminal 13 of TS-2. Solder the other lead to terminal 13 of TS-3 (2 wires).

- [x] R-5, 910Ω (white, brown, brown, gold) resistor. Solder one lead to terminal 13 of TS-2 (4 wires). Solder the other lead to terminal 12 of TS-3 (2 wires).

- [x] 12-conductor cable. Remove 6″ of the jacket from one end of the cable and 5½″ from the other. Prepare the 12-conductor cable as shown in Figure 8.

- [ ] Connect the end of the cable with the long tan lead as follows: The other end of the cable will be connected later.

  - [x] Tan lead. Solder to terminal 8 of TS-2 (3 wires).
  - [x] Pink lead. Connect to terminal 3 of TS-2.
  - [x] Black lead. Connect to terminal 11 of TS-3.
  - [x] Green lead. Connect to terminal 10 of TS-3.
  - [x] Blue lead. Connect to terminal 9 of TS-3.
  - [x] Violet lead. Solder to terminal 8 of TS-3 (2 wires).
  - [x] Orange lead. Connect to terminal 7 of TS-3.
  - [x] Yellow lead. Solder to terminal 6 of TS-3 (2 wires).
  - [x] Gray lead. Solder to terminal 5 of TS-3 (2 wires).
  - [x] Brown lead. Solder to terminal 4 of TS-3 (2 wires).
  - [x] Red lead. Connect to terminal 2 of TS-3.
  - [x] White lead. Connect to terminal 1 of TS-3.

- [x] Large cable clamp. Place the clamp over the 12-conductor cable. Mount to the side of the chassis with a 6-32 screw, lockwasher and nut.

- [x] C-4, .22 μf tubular capacitor. Solder the lead from the end marked with a line to terminal 1 of TS-2 (2 wires). Solder the other lead to terminal 1 of TS-3 (2 wires).

- [x] R-4, 100Ω (brown, black, brown, gold) resistor. Solder one lead to terminal 3 of TS-2 (4 wires). Solder the other lead to terminal 3 of TS-3 (3 wires).

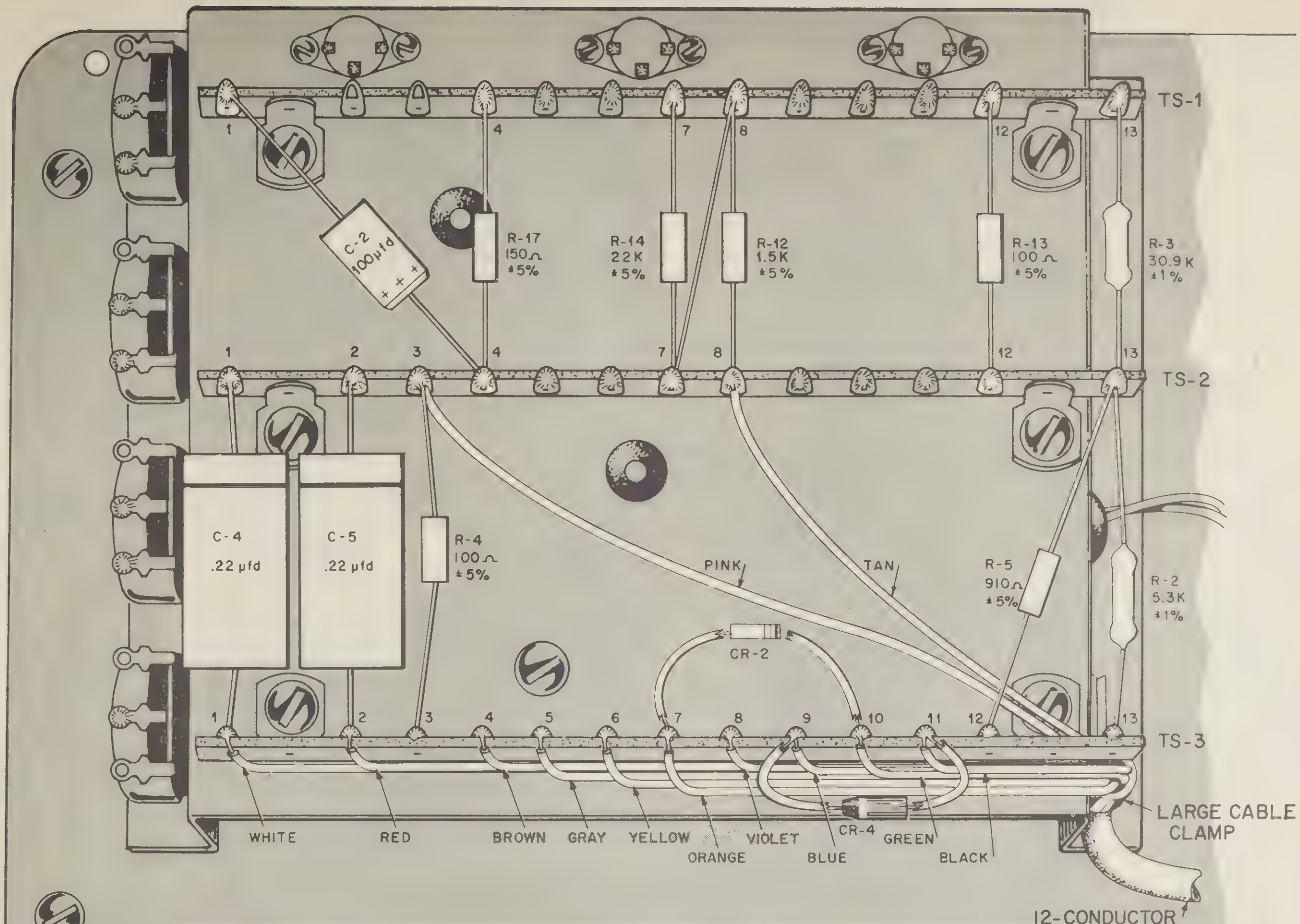
- [x] C-5, .22 μf tubular capacitor. Solder the marked end to terminal 2 of TS-2 (3 wires). Solder the other lead to terminal 2 of TS-3 (2 wires).

- [x] CR-2, glass diode. Place a 1″ piece of tubing over each lead. Solder the marked lead to terminal 10 of TS-3 (3 wires). Solder the other lead to terminal 7 of TS-3 (2 wires).

- [x] CR-4, bullet shaped diode. The marked end of this diode is denoted by a white band. Place a ½″ piece of tubing over each lead. Solder the marked end to terminal 9 of TS-3 (2 wires). Solder the other lead to terminal 11 of TS-3 (3 wires).

- [ ] The wiring of the chassis is now complete. Carefully recheck your wiring to be sure that all connections are correct. Make sure that all connections, with the exception of terminal 3 of R-22, are soldered and that no wires are shorted to the chassis or other terminals.

FIGURE 7. SECOND WIRING ON THE CHASSIS



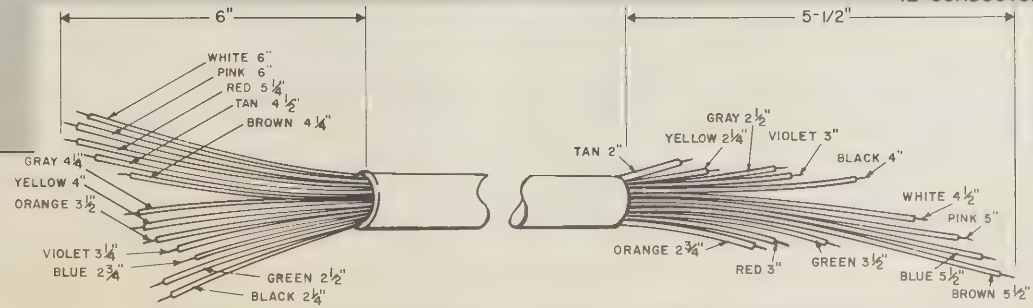


FIGURE 8. PREPARATION OF THE 12-CONDUCTOR CABLE

PARTS MOUNTING ON THE SUB-PANEL

SEE FIGURE 9

☑ Position the sub panel as shown in the figure.

NOTE: The two receptacles J-1 and J-2 are polarized and must be mounted exactly as instructed. Note the two leads on the receptacles; one has a **ribbed** surface, and the other is smooth.

☐ J-1, black receptacle. Mount by sliding the grooved edge of the receptacle into the cut-out in the panel. Mount with the **ribbed** lead to the left.

☑ J-2, white receptacle. Mount with the **ribbed** lead to the left.

☑ S-2, slide switch. Position with the color dot as shown. Fasten with two 6-32 flat-head screws.

☑ TS-4, 4-terminal strip. Mount with a 6-32 flat-head screw, two lockwashers, and a nut. Place one of the lockwashers between the terminal strip and panel and the other between terminal strip and nut.

☑ I-2, neon bulb. This is the bulb with the white dot. Place the bulb in the large cable clamp with the white dot positioned as shown. Mount the cable clamp to the panel with a 6-32 flat-head screw, lockwasher, and nut.

☑ Place a ½" piece of tubing over each lead of the bulb. Connect the lead nearest the white dot to terminal 2 of TS-4. Connect the other lead to terminal 3 of TS-4.

☑ Set the sub-panel aside, it will be mounted later.

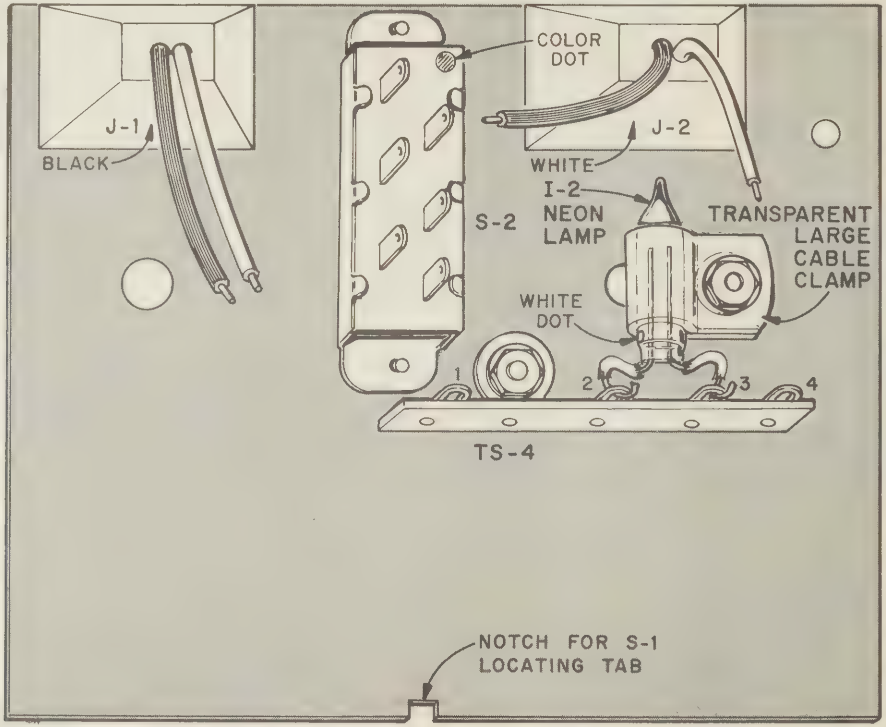


FIGURE 9. PARTS MOUNTING ON THE SUB-PANEL

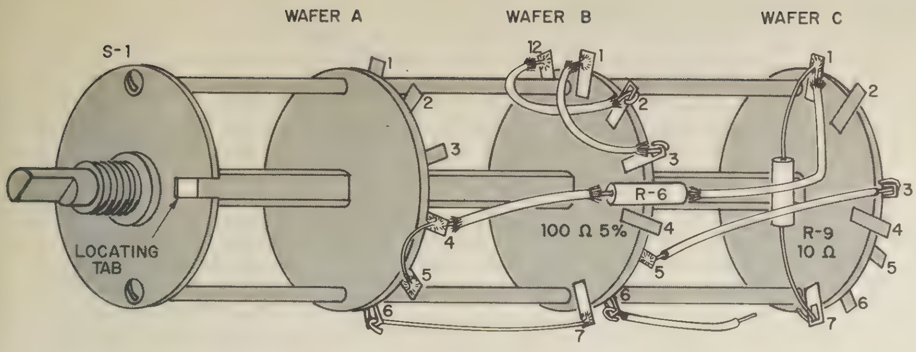


FIGURE 10. PREWIRING THE SELECTOR SWITCH

PRE-WIRING THE SELECTOR SWITCH

SEE FIGURE 10

- [x] Position the switch with the locating tab as shown.
- [x] R-9, 10Ω (brown, black, black) resistor. Connect one lead to terminal 1 of wafer C. Connect the other lead to terminal 7 of wafer C.
- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 4 of wafer A. Solder the other end to terminal 5 of wafer A.
- [x] Cut a 1¼″ piece of bare wire. Connect one end to terminal 6 of wafer A. Solder the other end to terminal 7 of wafer B.
- [x] R-6, 100Ω (brown, black, brown, gold) resistor. Place a ½″ piece of tubing over one lead. Solder this lead to terminal 4 of wafer A (2 wires). Place a 1″ piece of tubing over the other lead. Solder this lead to terminal 1 of wafer C (2 wires).
- [x] Cut a 1¼″ piece of bare wire. Place a ¾″ piece of tubing over the wire. Connect one end to terminal 2 of wafer B. Solder the other end to terminal 12 of wafer B. Also see Figure 11 for location of terminal 12.
- [x] Cut a 1″ piece of bare wire. Place a ½″ piece of tubing over the wire. Connect one end to terminal 3 of wafer B. Solder the other end to terminal 1 of wafer B.
- [x] Cut a 1¼″ piece of bare wire. Place a ¾″ piece of tubing over the wire. Solder one end to terminal 5 of wafer B. Connect the other end to terminal 3 of wafer C.
- [x] Red wire. Connect one end to terminal 6 of wafer B. The other end will be connected later.

SECOND WIRING ON THE SELECTOR SWITCH

SEE FIGURE 11

- [x] Turn the switch over so that the locating tab is now to the rear.
- [x] Red wire connected to terminal 6 of wafer B in the previous switch wiring. Connect the free end to terminal 9 of wafer C.
- [x] Cut a ¾″ piece of bare wire. Connect one end to terminal 8 of wafer C. Solder the other end to terminal 9 of wafer C (2 wires).
- [x] Cut three 1¼″ pieces of bare wire. Connect as follows:
  - [x] Connect one end of one of the wires to terminal 7 of wafer A. Solder the other end of this wire to terminal 8 of wafer B.
  - [x] Connect one end of one of the wires to terminal 8 of wafer A. Solder the other end to terminal 9 of wafer B.
  - [x] Connect one end of the last wire to terminal 9 of wafer A. Solder the other end to terminal 10 of wafer B.

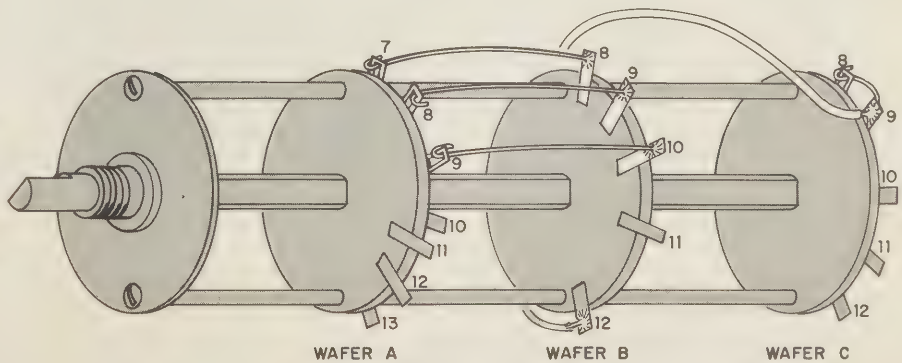


FIGURE 11. SECOND WIRING ON THE SELECTOR SWITCH

MOUNTING THE SUB-PANEL

SEE FIGURE 12

- [x] Position the front panel as shown in the figure.
- [x] Remove the handle mounting screw from the upper right-hand corner of the panel.
- [x] Mount the sub-panel by inserting the two receptacles through the cutouts in the front panel. Fasten the sub-panel and the handle to the front panel with the screw and lockwasher previously removed. Do not tighten this screw all the way as some alignment of the sub-panel may be necessary.

NOTE: There are two sizes of 3/8″ lockwashers used in this kit. The smaller one is used to mount S-3. When mounting the following parts, the lockwasher is placed between the part and panel and the flatwasher between panel and nut.

- [x] S-3, push button switch. Place the small lockwasher over the shaft of the switch. Mount by inserting the knob through the holes in the sub-panel and front panel. Fasten with a 3/8″ flatwasher and nut.
- [x] Tighten the screw which mounts the sub-panel and handle.
- [x] S-1, prewired selector switch. Place a lockwasher over the switch shaft. Mount by inserting the shaft through the hole in the panel. Insert the switch locating tab into the notch in the sub-panel. Fasten with a 3/8″ flatwasher and nut.
- [x] R-21, 30Ω control. Mount with a 3/8″ lockwasher, flatwasher, and nut.
- [x] R-19, 250Ω control. Mount with a 3/8″ lockwasher, flatwasher, and nut.
- [x] Cut a 3/4″ piece of bare wire. Solder one end to terminal 3 of R-21. Connect the other end to terminal 2 of R-21.
- [x] Yellow wire. Solder one end to terminal 1 of R-21. Solder the other end to terminal 3 of R-22 (2 wires).
- [x] Brown wire. Solder one end to terminal 2 of R-21 (2 wires). Solder the other end to terminal 7 of S-1C (2 wires).
- [x] Blue wire. Solder one end to terminal 3 of R-19. Solder the other end to terminal 4 of S-1C.
- [x] Cut a 3/4″ piece of bare wire. Connect one end to terminal 1 of R-19. Connect the other end to terminal 2 of R-19.
- [x] R-18, 10K (brown, black, orange, gold) resistor. Place a 1″ piece of tubing over each lead. Solder one lead to terminal 2 of R-19 (2 wires). Solder the other lead to terminal 3 of S-3.
- [x] Yellow wire. Solder one end to terminal 2 of S-3. Solder the other end to terminal 13 of S-1A.
- [x] Cut a 1 1/4″ piece of bare wire. Place a 3/4″ piece of tubing over the wire. Solder one end to terminal 1 of S-2. Connect the other end to terminal 6 of S-2.
- [x] Cut a 3/4″ piece of bare wire. Connect one end to terminal 2 of S-2. Connect the other end to terminal 5 of S-2.
- [x] Green wire. Solder one end to terminal 2 of S-2 (2 wires). Solder the other end to terminal 6 of S-1B (2 wires).
- [x] Blue wire. Connect one end to terminal 3 of S-2. Solder the other end to terminal 12 of S-1A.
- [x] Blue wire. Solder one end to terminal 6 of S-2 (2 wires). Connect the other end to terminal 11 of S-1C.
- [x] Blue wire. Connect one end to terminal 4 of TS-4. Solder the other end to terminal 10 of S-1C.
- [x] Green wire. Connect one end to terminal 2 of TS-4. Solder the other end to terminal 5 of S-1C.

CAUTION: When connecting the leads from the two receptacles, be sure to follow instructions exactly.

- [x] **Ribbed** lead from J-1. Connect to terminal 1 of TS-4.
- [x] Smooth lead from J-1. Solder to terminal 3 of S-1A.
- [x] **Ribbed** lead from J-2. Connect to terminal 4 of S-2.
- [x] Smooth lead from J-2. Connect to terminal 3 of TS-4.
- [x] R-10, 10Ω (brown, black, black) resistor. Place a 3/4″ piece of tubing over each lead. Solder one lead to terminal 1 of TS-4 (2 wires). Solder the other lead to terminal 4 of TS-4 (2 wires.)

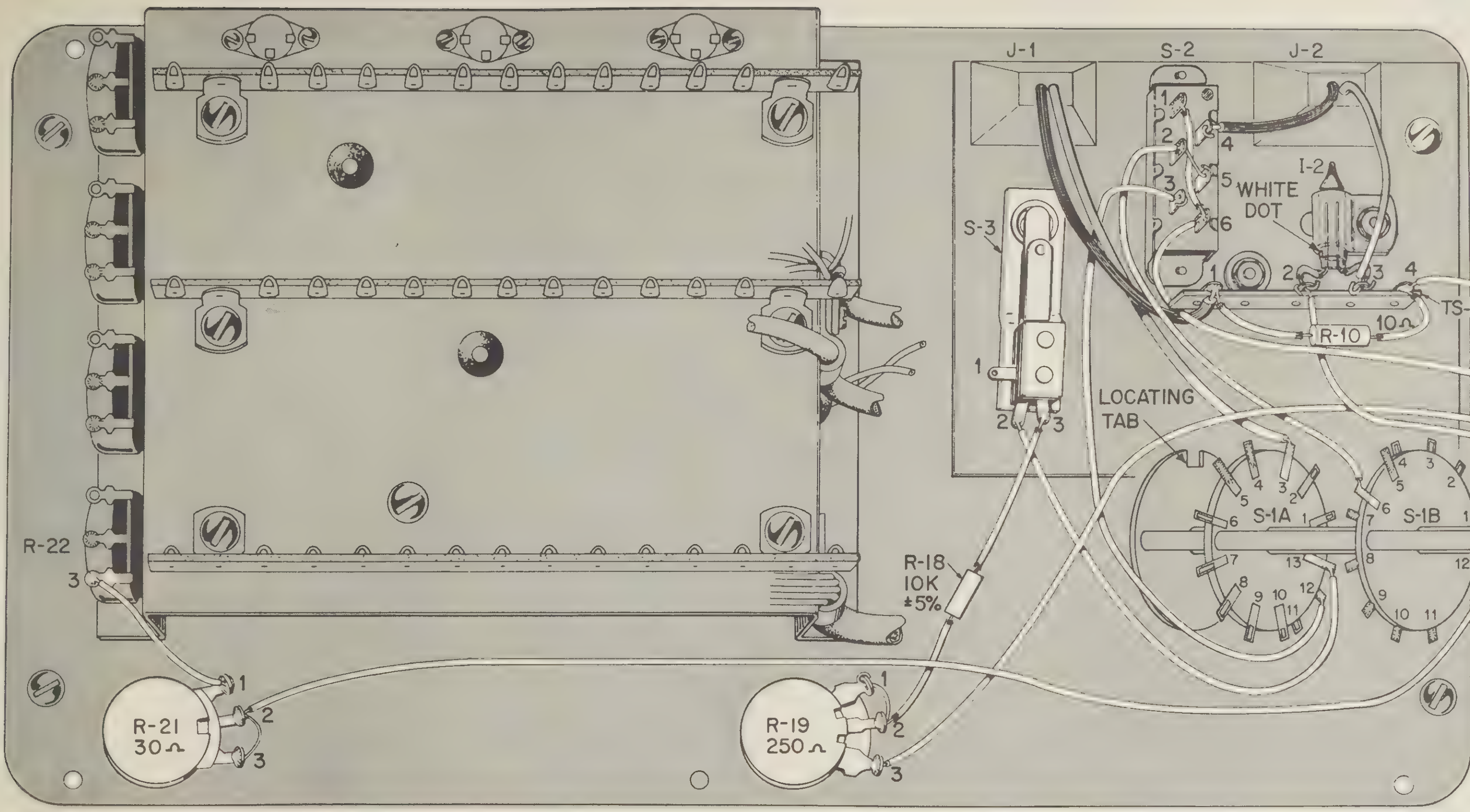


FIGURE 12. MOUNTING THE SUB-PANEL

FIRST WIRING ON THE PANEL

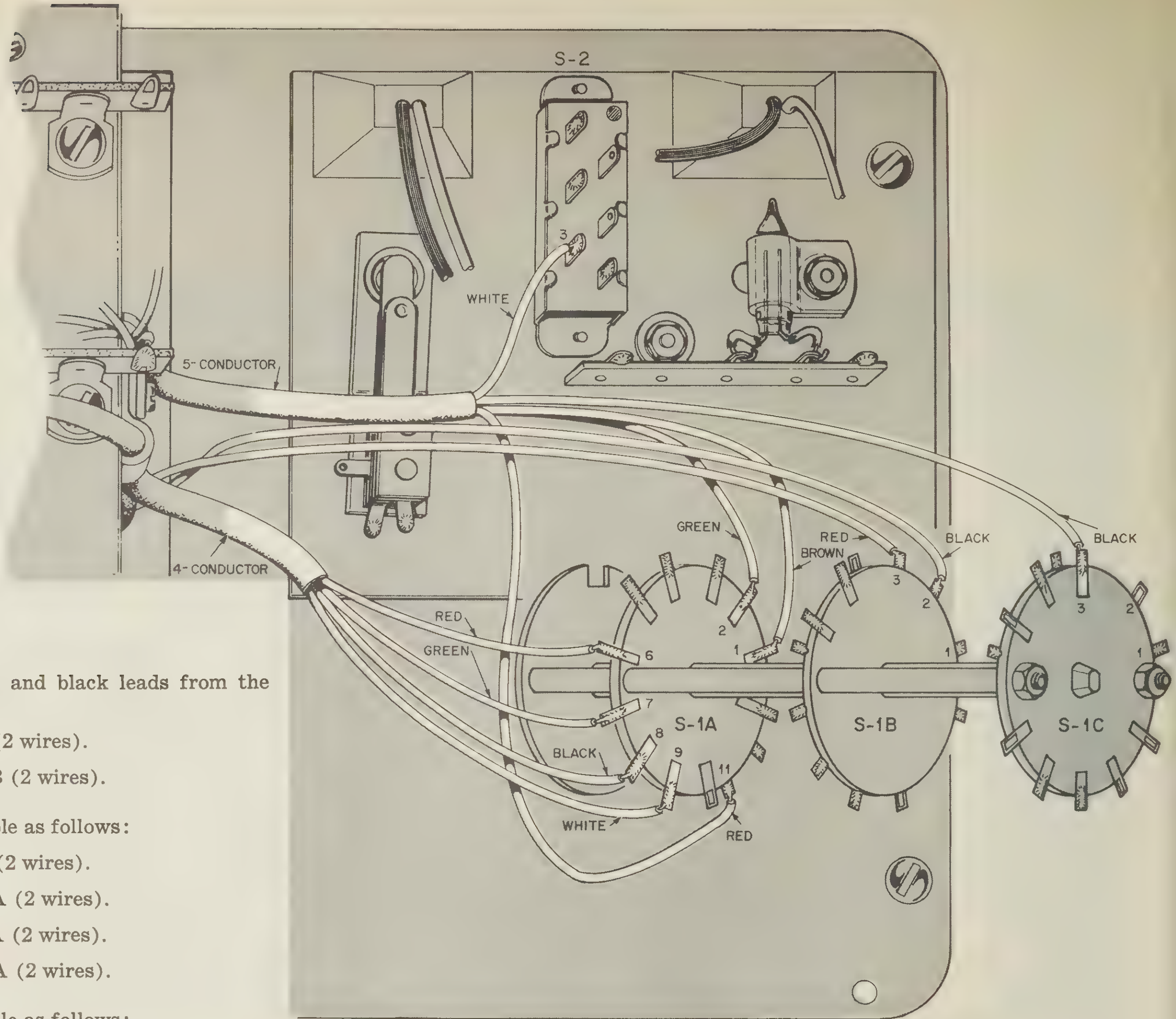


FIGURE 13. FIRST WIRING ON THE PANEL

SEE FIGURE 13

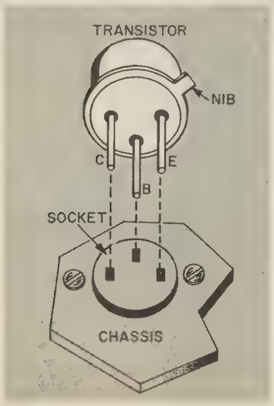
- [ ] Connect the free ends of the twisted red and black leads from the grommet as follows:
  - [ ] Red lead. Solder to terminal 3 of S-1B (2 wires).
  - [ ] Black lead. Solder to terminal 2 of S-1B (2 wires).
- [ ] Connect the leads from the 4-conductor cable as follows:
  - [ ] Red lead. Solder to terminal 6 of S-1A (2 wires).
  - [ ] Green lead. Solder to terminal 7 of S-1A (2 wires).
  - [ ] Black lead. Solder to terminal 8 of S-1A (2 wires).
  - [ ] White lead. Solder to terminal 9 of S-1A (2 wires).
- [ ] Connect the leads from the 5-conductor cable as follows:
  - [ ] White lead. Solder to terminal 3 of S-2 (2 wires).
  - [ ] Red lead. Solder to terminal 11 of S-1A.
  - [ ] Green lead. Solder to terminal 2 of S-1A.
  - [ ] Brown lead. Solder to terminal 1 of S-1A.
  - [ ] Black lead. Solder to terminal 3 of S-1C (2 wires).

FINAL WIRING

SEE FIGURE 14

- [ ] Connect the leads of the 12-conductor cable as follows:
  - [x] Tan lead. Solder to terminal 1 of R-19 (2 wires).
  - [x] Yellow lead. Solder to terminal 1 of S-3.
  - [x] Brown lead. Solder to terminal 4 of S-2 (2 wires).
  - [x] White lead. Solder to terminal 2 of TS-4 (3 wires).
  - [x] Pink lead. Solder to terminal 3 of TS-4 (3 wires).
  - [x] Green lead. Solder to terminal 4 of S-1B.
  - [x] Red lead. Solder to terminal 6 of S-1C.
  - [x] Gray lead. Solder to terminal 10 of S-1A.
  - [x] Orange lead. Solder to terminal 11 of S-1B.
  - [x] Violet lead. Solder to terminal 8 of S-1C (2 wires).
  - [x] Black lead. Solder to terminal 11 of S-1C (2 wires).
  - [x] Blue lead. Solder to terminal 12 of S-1C.
- [ ] Three transistors. Cut each lead to ¼″. Insert in the transistor sockets as shown in Detail A.

NOTE: The wiring of the unit is now complete with the exception of the two battery connections. Carefully recheck your wiring to be sure that all connections are correct. All connections with the exception of terminals 5 of S-2 and 2 of S-1C should be soldered at this time.



DETAIL A.

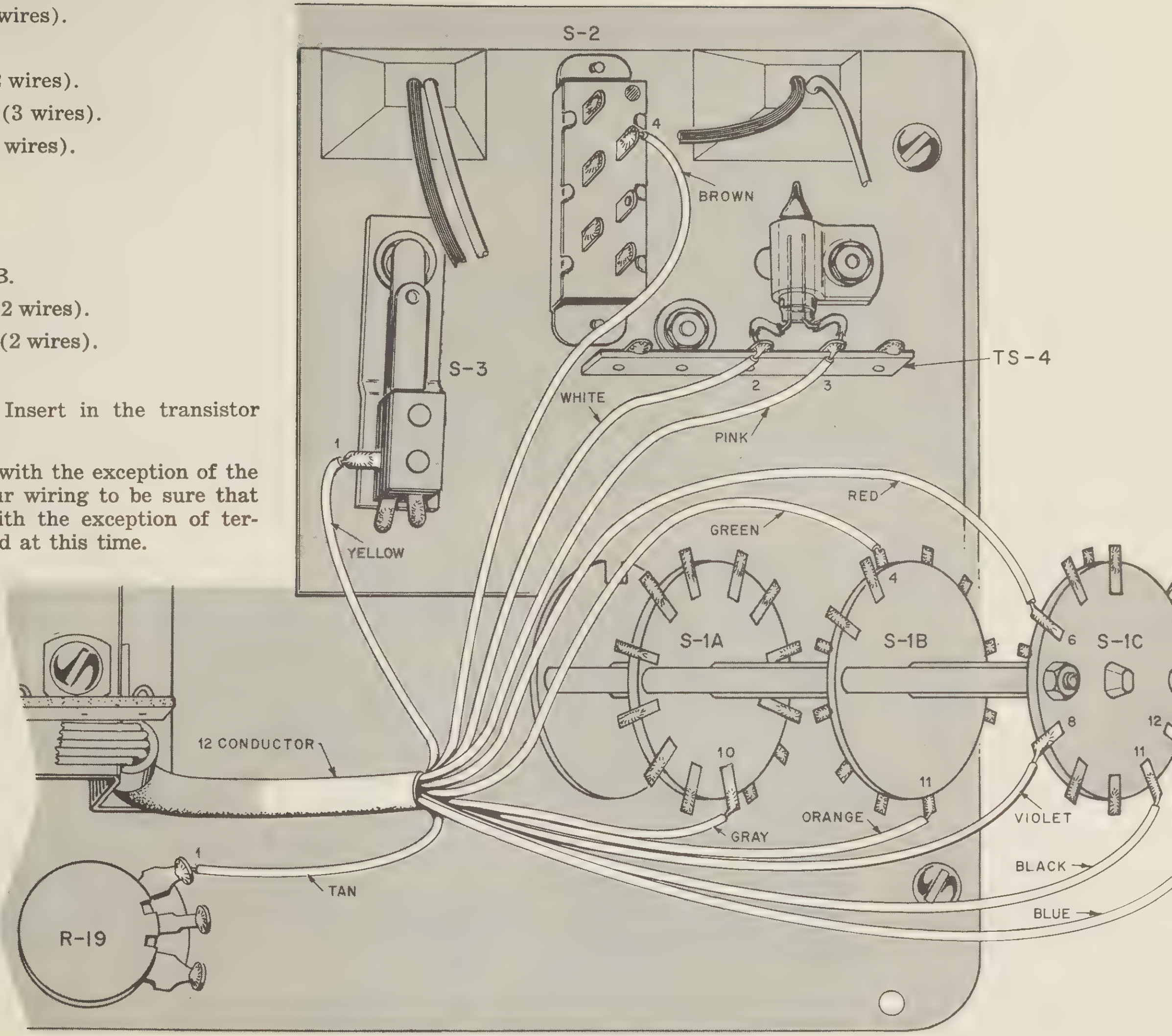


FIGURE 14. FINAL WIRING

FINAL ASSEMBLY

SEE FIGURE 15

- [ ] Four plastic feet. Mount to the bottom of the case as shown in Figure 16.
- [ ] Battery tube. Position in the case as shown. Mount with two small self-tapping screws. The holes for mounting the tube are in the compartment in the rear of the case.
- [ ] Position the assembled unit in front of the case as shown in the figure.
- [ ] Connect the two leads from the battery tube as follows:
    - [ ] Red lead. Solder to terminal 5 of S-2 (2 wires).
    - [ ] Blue lead. Solder to terminal 2 of S-1C.
- [ ] Mount the unit to the case with six large, thread-cutting screws.
- [ ] Rear cover and rear door. Slide the rear cover hinges into the slots in the rear door. Mount the rear door and cover on the back of the case. Fasten the rear cover to the case with five large thread-cutting screws.
- [ ] Door latch, plunger and plastic pull tab. Mount these parts to the rear door as shown in Figure 17. Be sure to seat the plunger all the way into the latch.
- [ ] Unscrew the battery tube cover. The batteries may have a piece of protective tape across the terminals. If so, remove before installing them. Install the batteries by dropping them into the battery tube, negative side (flat side of battery) first. Replace the cover.
- [ ] Plastic jewel. Press into the SPARK OUTPUT hole in the front panel.
- [ ] Two small knobs. Push over the shafts of the OHMS and RPM controls.
- [ ] Large knob. Place over the shaft of the selector switch. Fasten by tightening the setscrew down on the flat portion of the switch shaft.

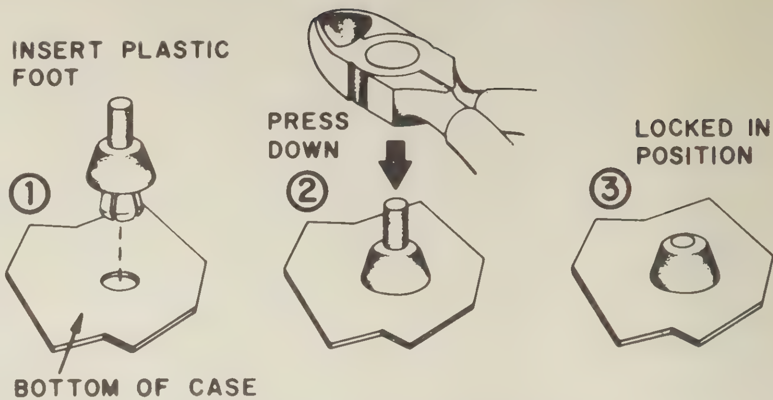


FIGURE 16. FOOT MOUNTING

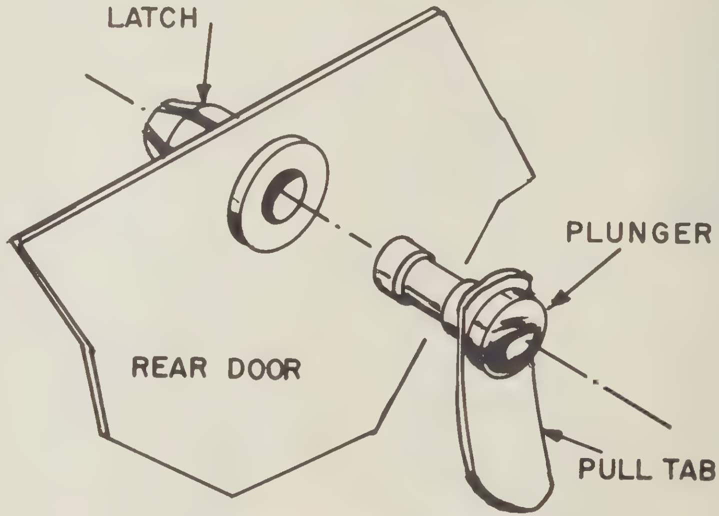


FIGURE 17. LATCH ASSEMBLY

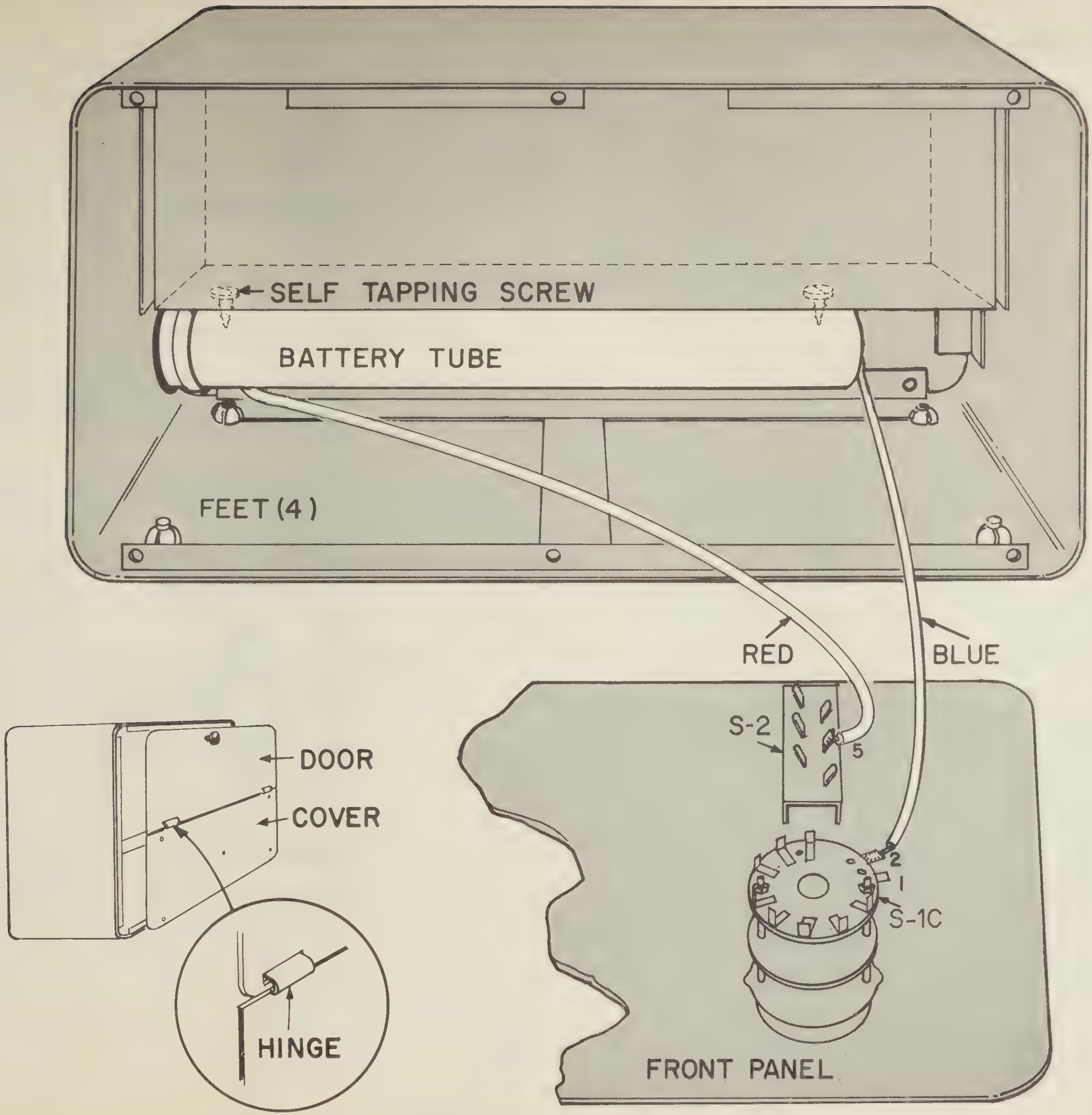


FIGURE 15. FINAL ASSEMBLY

TEST PLUG ASSEMBLY

SEE FIGURE 18

☐ White cord. Split back the ends of the cord approximately 12 **inches**. When using this plug, the cord can be split back as far as necessary to make any test connections.

☐ Place the red insulator over the lead having the **ribbed** surface. This ribbed surface must match up with that of the receptacles mounted in the unit. Twist the end of this lead around the screw of one of the alligator clips and then tighten the screw. Bend the two tabs of the alligator clip down over the lead.

☐ Place a black insulator over the smooth lead of the cord. Mount an alligator clip to this lead in the same manner.

☐ Slide the two insulators down over the alligator clips.

CALIBRATE PLUG ASSEMBLY

SEE FIGURE 19

☐ Unfasten the mounting screw from the plug. Set the plug cover and the screw and nut aside. They will be remounted later.

☐ Split the ends of the white cord back two inches from the end.

☐ Remove the two contacts with the screws from the plug. Attach one of the leads of the cord to each of the screws on the contacts. On this plug the ribbed lead can be connected to either one of the contacts.

☐ Insert the two contacts back into the plug.

☐ R-7, 120K (brown, red, yellow) resistor. Connect across the two contacts by inserting the leads through the slots in the side of the contacts. Solder the resistor to the two contacts.

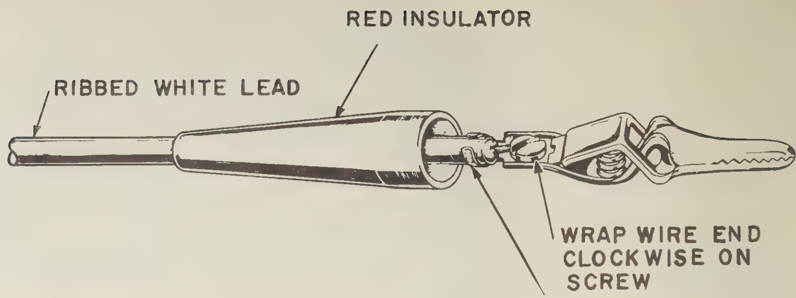


FIGURE 18. TEST PLUG ASSEMBLY

☐ R-8, 120K (brown, red, yellow) resistor. Solder to the other two contacts.

☐ Fasten the plug cover to the plug with the screw and nut.

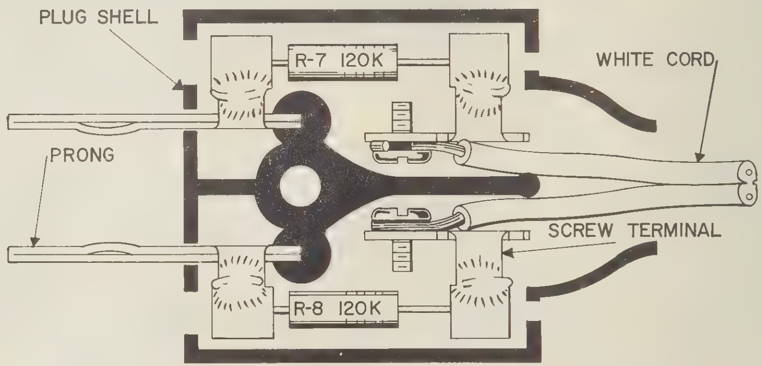


FIGURE 19. CALIBRATE PLUG ASSEMBLY

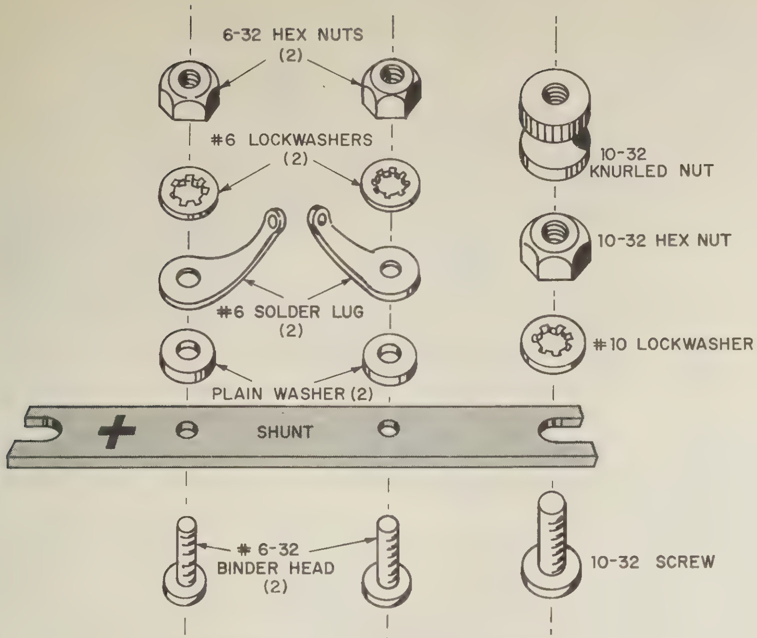


FIGURE 20. SHUNT ASSEMBLY

ASSEMBLING THE SHUNT

SEE FIGURE 20

- ☐ Position the shunt with the side marked with the + as shown in the figure.

- ☐ 10-32 screw, lockwasher, nut and knurled nut. Assemble in the slot as shown.

- ☐ Two solder lugs. Mount with two 6-32 screws, flatwashers, lockwashers, and nuts. Bend the two solder lugs up as shown in Figure 21.

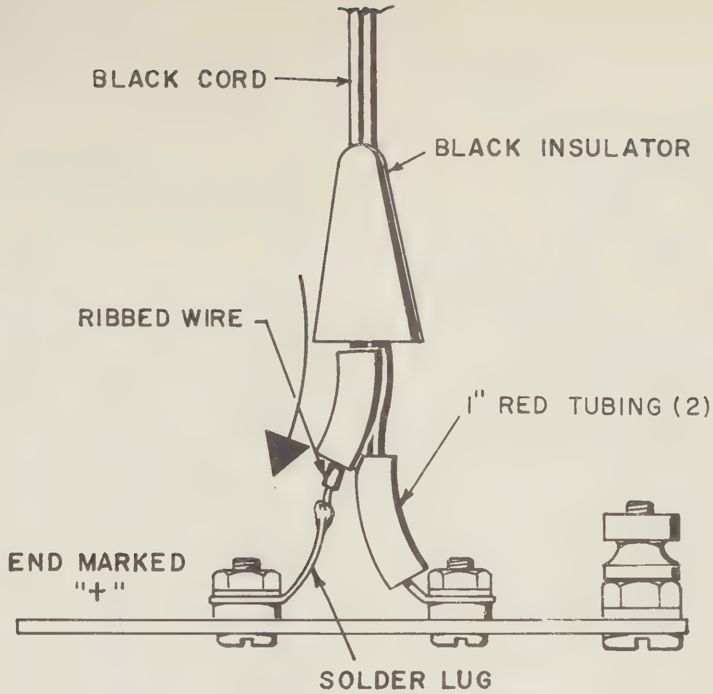


FIGURE 21. SHUNT WIRING

WIRING THE SHUNT

SEE FIGURE 21

- ☐ Black cord. Slide a black insulator over the leads of the cord. Split back the cord two inches from the end. Place a 1″ piece of red tubing over the **ribbed** lead of the cord. Solder this lead to the solder lug nearest the + side of the shunt. Be sure the **ribbed** lead is used for this connection.

- ☐ Place a 1″ piece of red tubing over the smooth lead of the cord. Solder this lead to the other solder lug.

- ☐ Slide the two pieces of red tubing down over the solder lugs.

- ☐ Slide the black insulator down over both solder lugs.

NOTE: The wiring of the unit is now complete. For complete operating and maintenance instruction see the operators manual. Before using the unit the analyzer must be calibrated. See the operators manual for calibration instructions.

PARTS LIST

CAPACITORS

Symbol	Description	Part No.
C-1	.1 μfd, 200 volt	243014
C-2	100 μfd, 6 volt	220107
C-3	1.0-5.0 μfd, 200 volt	299080
C-4	.22 μfd, 400 volt	248158
C-5	.22 μfd, 400 volt	248158
C-6	.22 μfd, 400 volt	248158

RESISTORS

R-1	12K	301123
R-2	5.3K, 1%	345301
R-3	30.9K, 1%	343092
R-4	100Ω, 5%	302101
R-5	910Ω, 5%	302911
R-6	100Ω, 5%	302101
R-7	120K	301124
R-8	120K	301124
R-9	10Ω	301100
R-10	10Ω	301100
R-11	15K, 5%	302153
R-12	1.5K, 5%	302152
R-13	100Ω, 5%	302101
R-14	22K, 5%	302223
R-15	15K, 5%	302153
R-16	1.5K, 5%	302152
R-17	150Ω, 5%	302151
R-18	10K, 5%	302103
R-19	250Ω, Control	392205
R-20	150Ω, Control	392203
R-21	30Ω, Control	407151
R-22	150Ω, Control	392203
R-23	150Ω, Control	392203
R-24	150Ω, Control	392203

SWITCHES

S-1	Selector	437121
S-2	6-Terminal, Slide	431302
S-3	Push Button	437112

JACKS AND SOCKETS

J-1	Black Receptacle	809126
J-2	White Receptacle	809124
TR-1	Transistor, Socket	509069
TR-2	Transistor, Socket	509069
TR-3	Transistor, Socket	509069

TERMINAL STRIPS

Symbol	Description	Qty.	Part No.
TS-1	13-Terminal	1	440902
TS-2	13-Terminal	1	440902
TS-3	13-Terminal	1	440902
TS-4	4-Terminal	1	440407

TRANSISTORS AND DIODES

Symbol	Description	Part No.
CR-1	Diode, Glass	630058
CR-2	Diode, Glass	630058
CR-3	Diode, Glass	630058
CR-4	Diode, Silicon	630061
TR-1	Transistor	660072
TR-2	Transistor	660072
TR-3	Transistor	660072

HARDWARE

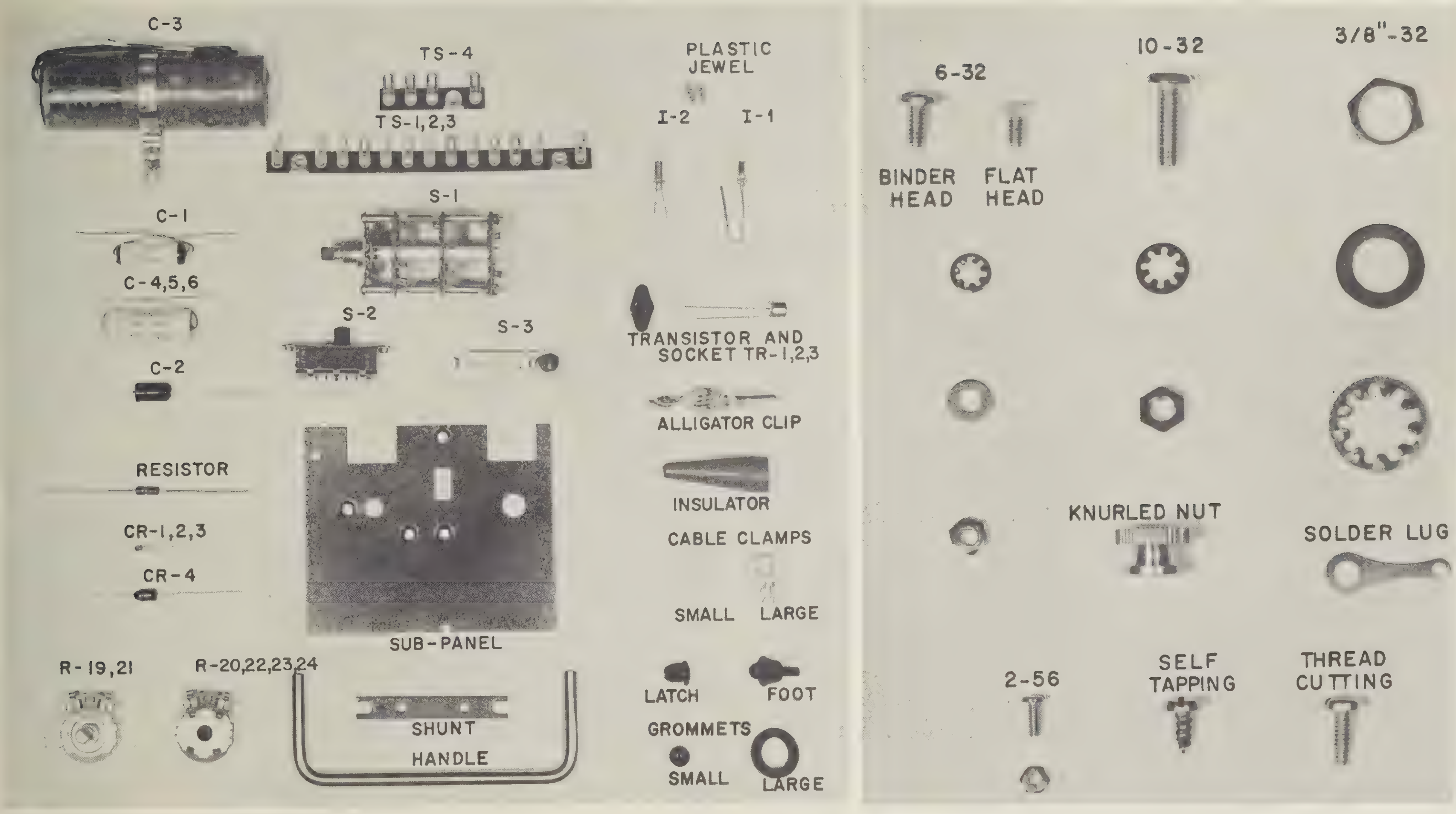
Description	Qty.	Part No.
Lockwasher, #6	16	582300
Lockwasher, #10	1	582500
Lockwasher, 3/8″	3	582700
Lockwasher, Thin, 3/8″	1	582701
Nut, 2-56	6	570000
Nut, 6-32	12	570340
Nut, 3/8″	4	570840
Nut, 10-32	1	570540
Nut, Knurled	1	579760
Screw, 2-56 x 1/4″	6	560002
Screw, 6-32 x 5/16″	14	560343
Screw, 10-32 x 3/16″	1	560576
Screw, Flathead, 6-32 x 5/16″	4	563343
Screw, Self Tapping #6 x 5/16″	2	562393
Screw, Large Thread Cutting, #6 x 3/8″	12	562398
Solder Lug	2	553002
Washer, #6	2	580300
Washer, 3/8″	4	580702

WIRE, SOLDER AND TUBING

Description	Qty.	Part No.
Red, 2″	10	807022
Orange, 3″	1	807023
Yellow, 4″	5	807024
Green, 5″	4	807025
Blue, 6″	4	807026
Brown, 10″	1	807021
Bare Wire, 24″	1	800600
White, Test Lead	2	809125
Black, Test Lead	1	809127
Cable, 4-Conductor	1	809130
Cable, 5-Conductor	1	809131
Cable, 12-Conductor	1	809132
Tubing, Small Black 24″	1	812001
Tubing, Large Red 2″	1	812007
Solder, 6′	1	930004

MISCELLANEOUS

Battery, Size D	4	450012
Case	1	702092
Chassis	1	463568
Clamp, Large, Plastic	2	880092
Clamp, Small, Plastic	2	880072
Cover, Rear	1	470650
Clips, Alligator	2	532005
Door, Rear	1	470650
Feet, Cabinet	4	880084
Grommet, Large	1	830005
Grommet, Small	2	830001
Handle	2	470649
I1, Neon Bulb	1	640013
I2, Neon Bulb with White Dot	1	642001
Insulator, Red	1	880003
Insulator, Black	2	880004
Jewel	1	644563
Knob, Large	1	765073
Knob, Small	2	765076
Lock, Plunger	1	880086
Lock, Latch	1	880087
Meter	1	659266
Panel, Front	1	463569
Panel, Sub	1	463567
Plug, Calibration	1	509086
Shunt, Ammeter	1	809133
Tab, Pull	1	860165
Tube, Battery	1	880085



PARTS IDENTIFICATION CHART

KNIGHT-KIT SERVICE FACILITIES

TECHNICAL CONSULTING SERVICE

If, after following the instructions and suggestions given in this manual you are still unable to obtain proper performance from your kit, we invite you to contact our Technical Consulting Service for further assistance. Please be as accurate and thorough as possible because the effectiveness of our advice depends entirely on the information you supply.

Use the following as a guide for your correspondence:

1. Have you checked all the suggestions under Service Hints? Careful consideration of these points may solve your problem without writing.
2. Be sure to give the kit model number, the date of purchase and the serial numbers on the label pasted on the chassis and the back cover of the manual.
3. Have you made a thorough check of all wiring and soldering? Each solder connection should have a shiny metallic finish. Reheat any connection that appears doubtful and add a little solder if needed. Be sure there are no parts accidentally touching each other, the chassis or nearby terminals.
4. If the kit is of the type that requires calibration or alignment, double check these procedures. Be as specific as possible in your report. Outline adjustments made and the alignment procedure employed.
5. When you write be sure to describe all associated equipment. Specifically note the switch positions. Define as clearly as possible the symptoms as noted and mention any particular circumstance under which the problem occurs (after unit has been on for some time, only when jarred or moved, only when used for a particular purpose, etc.).
6. If you have completed the recommended service hints, be sure to outline the results and note any measurements taken which are out of tolerance.

KNIGHT-KIT PARTS WARRANTY

Knight Electronics guarantees that only premium-quality parts are selected for use in Knight-Kits. Every Knight-Kit part is fully warranted for a period of one year from date of purchase against defects in material and workmanship. Prompt No-Charge replacements of defective parts will be made.

INSPECTION SERVICE

You may return your completed Knight-Kit for inspection and repair within one year from purchase for a service charge of $6.50 for this particular kit. An additional charge will be made for parts damaged in construction.

Kits not completely wired or which require extensive re-work will incur an additional labor charge. You will be notified of these charges prior to our repairing your kit.

No service charge will be made for a period of 90 days from date of purchase, if malfunctioning of the completed kit is due to a defective part. Service charges for kits returned after the one year period will be on a time and materials basis.

PACKING INSTRUCTIONS

Should you find it necessary to return your Knight-Kit be sure to pack it carefully. The original carton is not sufficiently large; use a carton large enough so that ample cushioning material can be placed around the unit. TO PREVENT COSTLY DAMAGE IN TRANSIT, cushion your Knight-Kit tightly using plenty of packing materials. Mark: FRAGILE—DELICATE ELECTRONIC EQUIPMENT.

SHIPPING INSTRUCTIONS

For safety, your unit should be shipped by REA Express Prepaid and Insured. Please include remittance to cover repair costs. This will save you costly COD fees; any excess remittance will be refunded. Your repaired unit will be returned to you REA Express collect.

When you return a kit please enclose your order papers and a letter explaining why you are returning the unit.

ADDRESS CORRESPONDENCE AND RETURN KITS TO:

KNIGHT ELECTRONICS CORP.
Knight-Kit Service Department
2100 Maywood Drive • Maywood, Illinois

This is the ultra-modern Knight Electronics plant in Maywood, Illinois, a nearby suburb of Chicago. This extensive facility is devoted completely to the research, engineering, and manufacturing of quality electronic equipment in kit form. Knight pioneers in creating better electronic products at lower cost for hobbyists, experimenters, laboratories, schools, and industry.

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knight®

OPERATOR'S MANUAL

KG-375 UNIVERSAL AUTO ANALYZER

TABLE OF CONTENTS

A. SPECIFICATIONS

VOLTS	DC 0-3.2 0-16
AMPERES	DC 0-90
RPM	0-1200 0-6000 4, 6, 8 cylinder engines, Schmidt trigger pulse counter, 3 transistor.
DWELL	0-45° 8 cylinder engines 0-90° 4 cylinder engines 0-60° 6 cylinder engines
OHMS	0-20,000 ohms, 100 ohm center scale.
DIODE	Alternator diode (ohmmeter with forward and reverse switch).
CONDENSER LEAKAGE	Ohmmeter.
SUBSTITUTE CONDENSER	.22 MFD 400V DC with switch.
BATTERY	4 size "D" flashlight cells.
METER	7" Panoramic view with 10 scales. Movement is protected from damage of up to seven times full current.

B. WHAT THE KG-375 WILL DO

The Knight analyzer allows the mechanic to make accurate checks of voltage, current and resistance. These tests make trouble shooting quick and easy.

For tune-up work, the tachometer, spark output and dwell angle meters allow the mechanic to get maximum engine performance and economy. The following tests may be made with the analyzer:

VOLTAGE:

Two accurate scales, 0 to 3.2 volts and 0 to 16 volts are available.

CURRENT:

A separate test lead having an external shunt is provided for measuring current up to 90 amperes.

OHMS LEAKAGE DIODE:

This test provides an ohmmeter function. Resistance of from 0 ohms to infinity may be measured.

DWELL:

The dwell angle meter function provides a quick check of the distributor point adjustment.

RPM:

Four separate scales provide low and high speed tachometer functions for 4, 6 and 8 cylinder engines.

SPARK OUTPUT:

Allows relative high voltage measurements of the ignition secondary circuit.

SUBSTITUTE CONDENSER:

Allows you to substitute a condenser of good quality in place of the condenser suspected of being faulty.

C. SERVICE INFORMATION

Automobile technical service manuals are the most complete source of information available for your specific make and year of car.

We strongly recommend that you purchase one of the many automobile manuals available for your particular make of car. This will help you get maximum benefit from your unit.

These manuals can be obtained for late model cars from automobile manufacturers. Contact the district service or field office for your make of car. They will provide information for ordering and cost.

Smaller, less expensive manuals, for specific automobiles are available. They have titles such as: "How to Fix Your Ford", "How to Fix Your Chevrolet", etc.

Many very excellent general manuals are also available, such as "Motors Auto Repair Manual", "Motor Services Automobile Encyclopedia" and Glenn's "New Auto Repair Manual".

Manuals are also available for most popular foreign makes.

D. INSTRUMENT MAINTENANCE

CLEANING

Occasionally clean the meter face with a soap or detergent and water solution. DO NOT use strong solvents (gasoline or paint thinner).

REPLACING BATTERIES

Unscrew the circular cap in the left side of the case. Slide 4 "D" size 1½ volt flashlight cells flat end first into the plastic tube and push them until you can feel the resilient contact from the spring in the bottom. Re-cap (do not overtighten).

NOTE: While tightening the cap, set the function switch in the RPM position and push the RPM calibrate button to be sure a reading is obtained.

ZEROING THE METER

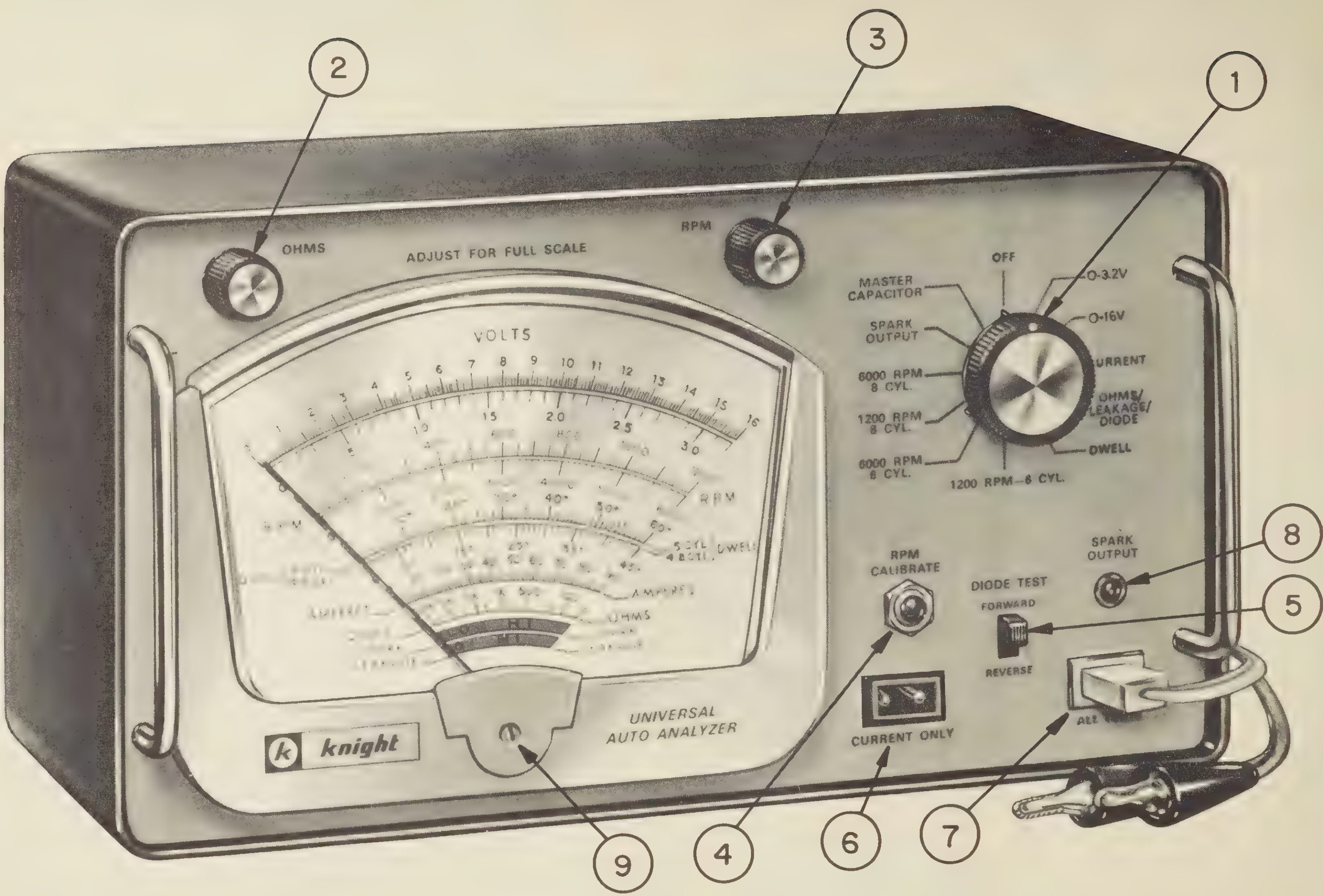
There is a slotted zero adjustment screw on the face of the meter near the bottom. Adjust the needle to zero by turning the adjusting screw. Be sure the function knob is in the OFF position.

E. CALIBRATING THE TACHOMETER

Internal calibration has been done during the manufacture of the instrument. Field calibration is done with a 60 cycle reference and the calibrating cord and plug.

To calibrate, proceed step by step as follows:

1. Insert the white lead of the calibrating plug in the white receptacle.
2. Insert the calibrating plug into a 110 volt, 60 cycle, AC outlet.
3. Set the function switch to the 1200 RPM / 6 cyl. position.
4. Press the RPM CALIBRATE button and adjust the small RPM knob for a full scale reading (1200 RPM).
5. Release red button. With a small screwdriver, adjust the control (thru the upper hole in the left side of the case) for a meter reading of 1200 RPM on the 1200 RPM scale.
6. Set the function switch to the 6000 RPM / 6 cyl. position.
7. Press the red button and adjust the small RPM knob for a full scale reading (6000 RPM).
8. Release the red button and adjust the control (thru the second hole down from the top in the left side of the case) to a reading of 1200 RPM on the 6000 RPM scale.
9. Set the function switch to the 1200 RPM / 4-8 cyl. position.
10. Press the red button and adjust the RPM knob for a full scale reading (1200 RPM).
11. Release the red button and adjust the control (thru the third hole from the top in the case) to a reading of 900 RPM on the 1200 RPM scale.
12. Set the function switch to the 6000 RPM / 4-8 cyl. position.
13. Press the red button and adjust the RPM knob for a full scale reading (6000 RPM).
14. Release the red button and adjust the RPM knob (thru the bottom hole in the left side of the case) for 900 RPM on the 6000 RPM scale.
15. The internal TACHOMETER controls are now calibrated.


OHMS
ADJUST FOR FULL SCALE
RPM
VOLTS
OFF
MASTER CAPACITOR
SPARK OUTPUT
6000 RPM 8 CYL.
1200 RPM 8 CYL.
6000 RPM 6 CYL.
1200 RPM—6 CYL.
O-3.2V
O-16V
CURRENT
OHMS/ LEAKAGE/ DIODE
DWELL
RPM CALIBRATE
DIODE TEST
FORWARD
REVERSE
SPARK OUTPUT
CURRENT ONLY
knight
UNIVERSAL AUTO ANALYZER
1
2
3
4
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8
9

F. DESCRIPTION OF PANEL FUNCTIONS

1. FUNCTION SWITCH	Selects desired test and range.
2. OHMS	Calibrates the meter for accuracy to compensate for internal dry cell voltage variation in the ohms and dwell positions.
3. RPM	Adjusts the meter for full scale in the RPM positions.
4. RPM CALIBRATE BUTTON	Press while setting RPM knob.
5. DIODE TEST	Reverses ohmmeter leads internally and measures forward and reverse resistance of diode.
6. AMPERES ONLY	Black receptacle, used with black test leads equipped with bar shunt for current measurement only.
7. OTHER TESTS	White receptacle, used with white leads to make all measurements EXCEPT CURRENT.
8. SPARK OUTPUT	Flashes when spark output is exceptionally good.
9. METER ADJUSTMENT	Positions needle at zero with function knob in OFF.

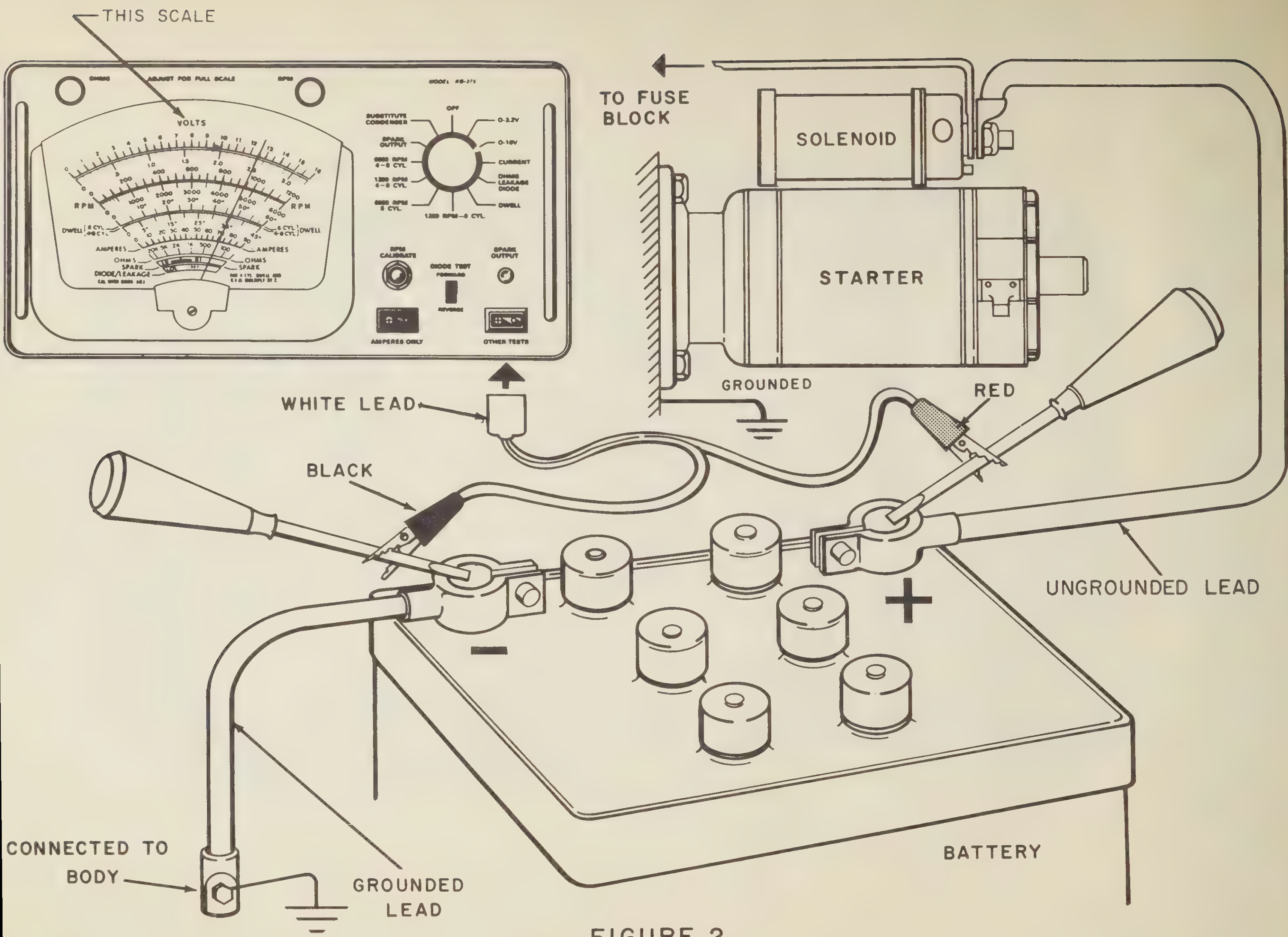


FIGURE 2
VOLTAGE

II. HOW TO USE THE VOLTMETER

A. Typical hookup

SEE FIGURE 2

1. Set the function switch to the 0-16v position.
2. Plug the white test plug into the white receptacle. The plug will only fit one way.
3. Connect the black clip to the negative terminal (—) of the circuit to be measured.
4. Connect the red clip to the positive terminal (+) of the circuit.
5. Observe the voltage reading on the 0-16v meter scale. If this reading is less than 3.2 volts, rotate the function switch to the 0-3.2v position and read the voltage on the corresponding meter scale.

B. Using the voltmeter to check the battery.

The voltmeter will give accurate indications of battery condition and the state of charge.

1. **State of charge.**
   The state of charge of a storage battery can be roughly determined by its terminal voltage without load. The terminal voltage of a fully charged 12 volt battery should be close to 12.6 volts (6 volt batteries should read ½ this value, or 6.3 volts). Individual cells should produce about 2.1 volts each. There should not be a variation of more than .05V between cells.

2. **Battery Capacity.**
   To start an automobile, the battery must deliver enough energy to operate the starter while at the same time providing sufficient energy for a good spark. Use the following procedure for determining battery capacity:

   a. Be sure that the battery is fully charged.
   (Check the specific gravity of the electrolye with a hydrometer. A reading of 1250 or more for each cell indicates a full charge).

   b. Pull the coil lead out of the center of the distributor cap and ground it to a convenient point.

   c. Set the function switch to the 0-16V position.

   d. Connect the clip leads to the battery terminal posts, red to positive post (+) and black to negative post (—).

   e. Turn on headlights, heater blower, etc.

   f. Check the voltage and then run the starter for 30 seconds. The cranking speed must remain normal and the voltage should be 9.5 volts or more with battery temperature above 30 degrees.

   NOTE: For 6v systems, the voltage readings should be ½ of those mentioned.

C. Starter ground return.

This test is useful for determining possible loose or dirty connections in the ground return path of the starter. Loose ground straps, or loose starter mounting bolts are often causes of poor starter operation. This test will locate these problems.

1. Set the function switch to the 0-3.2v position.
2. Pull the coil lead out of the center of the distributor cap and ground it to a convenient point.
3. Connect the red clip to the bare metal of the starter frame.
4. Connect the black clip directly to the grounded battery post (not the battery ground cable clamp).
5. Operate the starter and read the voltage on the 0-3.2v scale. The reading MUST NOT exceed .2v.

NOTE: If the meter reads backwards, such as with positive ground ignition systems, reverse the clip connections.

6. If trouble is indicated by the test above and all of the connections around the starter seem alright, perform the following test:

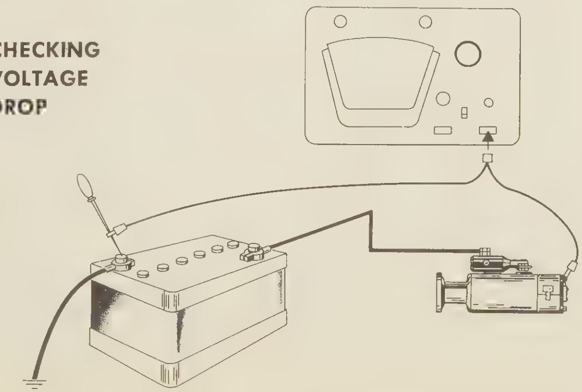
   a. Connect the red clip to the ground cable clamp. b. Connect the black clip directly to this battery post. c. Run the starter and check the voltage. More than .1v indicates a dirty battery connection. Remove and clean the battery cable clamp and battery post to correct this trouble.

D. Starter solenoid switch, battery lead and contacts. (See figure below)

The cable from the ungrounded battery post to the solenoid, the solenoid contacts, and the cable from the solenoid to the starter can be checked with the following procedure. On some cars, the solenoid to starter lead and the actual solenoid contacts are inaccessible. If this is the case, just delete those portions of the following test procedure.

1. Set the function switch to the 0-3.2v. position.
2. Connect the red clip lead to the ungrounded battery post and the black clip lead to the solenoid battery terminal.

CHECKING VOLTAGE DROP



3. Disconnect the coil wire from the distributor and connect it to ground. Turn the ignition switch on.
4. Operate the starter motor and note the voltmeter reading. It should not exceed .2 volt. If it does, either the cable or its connections are faulty.
5. If possible, (on some cars this will be impossible) connect the clip leads across the solenoid switch terminals. Red clip lead to the battery terminal of the solenoid switch and the black clip lead to the starter motor terminal. Operate the starter motor and note the voltmeter reading. It should not be more than .1 volt. If it is more, the solenoid switch contacts are faulty.
6. If possible, connect the clip leads across the cable going from the solenoid switch to the starter motor. Red clip lead to the solenoid switch and the black clip lead to the starter motor. Operate the starter motor and note the voltmeter reading. If it is more than .2 volt the cable or its connections are faulty.
7. Make the following test, if the starter solenoid does not seem to operate (does not "click") when the starter switch is operated. Connect the red clip to the small terminal on the solenoid (usually marked S). Connect the black clip to ground. Set the analyzer function switch in the 0-16v position. Operate the starter switch. The meter should read at least 9v. If it does not, starter switch wiring is faulty. If you do get a reading, and the solenoid still does not click, the solenoid is probably faulty.

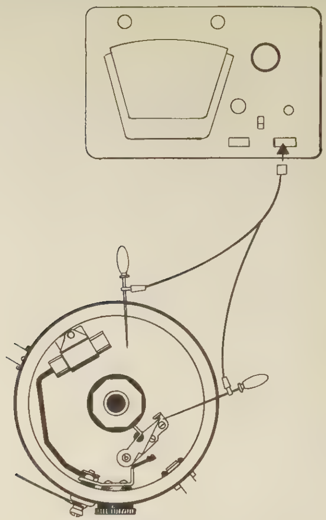
NOTE: Use ½ of the above voltage readings for 6v systems. If, when the connections are made as outlined above and the voltmeter reads backwards, reverse the clip leads.

E. Distributor, broken or shorted connections.

This test will quickly find broken or shorted distributor wires.

1. Connect the red clip to the small coil wire connected to the distributor. Connect the black clip to the coil clamp.
2. Set the function switch to the 0-16v position.
3. Pull the coil lead from the center of the distributor cap and ground it, so the engine won't start.
4. Turn the ignition on and operate the starter. The voltage should pulse upwards from 3 to 6 volts. (If the meter reads backwards, reverse test clip connections). If the voltage does not pulse, but remains near zero, connect the test leads directly across both primary terminals of the coil. Operate the starter again, a constant reading of 9v or more indicates a shorted wire or condenser, or points that do not open.
5. If the voltage did not pulse, but remained at 9v or more during the first test, an open circuit is indicated. Check for points that do not close, or loose or broken wires. Wires sometimes break inside the insulation. Refer to the "HOW TO USE THE OHMMETER" section of this manual to check a suspected wire.

STATIONARY POINT GROUNDING



F. Stationary point grounding. (See figure above)

Sometimes oil accumulations inside the distributor will cause a poor connection between the stationary point and distributor plate. Check for this condition in the following manner:

1. Pull the coil lead from the center of the distributor cap and ground it.
2. Remove the distributor cap.
3. Nudge the starter until the points close, leave the ignition switch on.
4. Connect the red clip to the stationary point. Connect the black clip to the plate that the points are mounted on. Set the function switch to the 0-3.2v position.
5. Measure the voltage between the stationary point and the base that it is mounted on. More than .05v means a poor connection. Remove and clean the points and distributor breaker plate.

G. Breaker Point Surfaces.

Checking the breaker points for a burned or dirty condition.

1. Set the function switch to the 0-16v position. Clip the red clip lead to the distributor terminal connected to the coil and the black clip lead to the coil bracket (ground). Turn the ignition switch on and nudge the starter motor until the points close. (This will be indicated by a low voltmeter reading.)

2. Set the function switch to the 0-3.2v position and note the voltmeter reading. If it is more than .1 volt, the points are faulty or they are not making good contact with the breaker plate.
   Bad points can be caused by:
   a. Regulator voltage too high.
   b. Oil fumes leaking past a worn distributor shaft or shaft bushing.
   c. Open condenser.
   d. Points spaced too close (check dwell).
   e. Normal wear.

NOTE: If the voltmeter reads backwards, reverse the clip leads.

H. Coil Primary Wiring.

In this section, the wiring of the primary circuit of the coil will be checked. This includes all leads and switches from the ungrounded battery terminal to the coil terminal. Ballast resistors, if any, will also be checked.

1. Turn the ignition switch on.
2. Ground the coil terminal connected to the distributor with a short length of wire.
3. Set the function switch of the analyzer to the 0-3.2v position and clip the red lead to the ungrounded battery post. Attach the other clip lead to the side of the ballast resistor connected to the ignition switch. There should be a reading no higher than .3 volt.

NOTE: If your car does not have a ballast resistor, or uses resistance wiring, go on to steps 6 and 7.

4. If a reading above .3 volt is obtained, there is a problem in the wiring of the ignition switch. Turn the ignition switch on and off several times and return it to the on position. If a different reading is now obtained, the ignition switch is probably faulty. Also check the wiring for frayed insulation and loose connections.

NOTE: If the voltmeter reads full scale, immediately switch to the 0-16v position. A reading of about 12 volts indicates on open ignition switch or broken wiring.

5. Disconnect the analyzer's leads and reconnect the red lead to the other terminal of the ballast resistor. Connect the black clip lead to the ungrounded coil terminal. A reading of no higher than .1 volt should be obtained. If it is higher, the wire from the resistor to the coil should be checked.
6. If your car does not have a ballast resistor, simply attach the red clip lead to the ungrounded battery post and the black clip lead to the ungrounded coil terminal. A reading no higher than .3 volt should be obtained. If it is more than .3 volt, check the ignition switch and wiring as explained in step 4.
7. If your car has resistance wiring (check with your auto manual or dealer) set the function switch to the 0-16v position. Connect the red clip lead to the ungrounded coil terminal and the black clip lead to ground. A reading from 4 to 6v indicates the wiring is good. Turn the ignition switch on and off several times and then return it to the on position. If the reading is within .2 volt of the previous reading, the switch is good.

NOTE: If the voltmeter reads backwards when the clip leads are attached as described, simply reverse the leads. This will be necessary if your system is positive ground.

J. Generator voltage capability.

This test will determine whether the generator produces voltage or not.

CAUTION: DO NOT race the engine when making this test. Racing the engine will cause the generator to produce excessive voltage.

1. To perform this test you must first determine if your car uses an internally or externally grounded generator. Most cars, with the exception of some Rambler-Nash-Hudson products and Ford Motor Company products use an EXTERNALLY grounded system.

   A. Externally grounded systems.
   1. Disconnect the wire from the field terminal (fld) of the generator.
   2. Connect the field terminal (fld) to the generator frame with a short length of wire.
   3. Connect the red clip to the armature terminal (arm) of the generator. Connect the black clip to the generator frame. Reverse clip connections for positive ground systems. Set the function switch to the 0-16v position.
   4. Start the engine and let it idle. Slowly increase engine speed while watching the meter. The voltage should increase to about 16 volts.

   B. Internally grounded systems.
   1. Disconnect the wire from the field terminal (fld) of generator.
   2. Connect the field terminal (fld) to the armature terminal (arm) with a short length of wire.
   3. Connect the red clip to the armature terminal (arm). Connect the black clip to the generator frame (reverse clip connections for positive ground systems). Set the function switch to the 0-16v position.
   4. Start the engine and let it idle. Slowly increase engine speed while watching the meter. The voltage should increase to about 16 volts.

   C. If in either case the voltage does not increase above battery voltage, it may be assumed that the generator is defective.

   NOTE: Be sure to reconnect the wires when the test is completed.

K. Cutout relay.

The cutout relay connects and disconnects the generator and battery. Use the following procedure to determine the exact cutout voltage.

1. Connect the red clip to the armature terminal arm of the generator. Connect the black clip to the generator frame (reverse connections for positive ground systems). Set the function switch in the 0-16v position.
2. Start the engine and run at about 3 times idle speed. Slowly decrease engine speed until the meter "hesitates" and drops back suddenly.
3. The lowest reading obtained before the meter dropped back suddenly is the cutout voltage. This voltage should be slightly below battery terminal voltage.

The cutout relay must disconnect the battery from the generator when the generator voltage drops below battery voltage. If the cutout relay fails to do this, the battery will discharge through the generator windings.

L. Generator Wiring.

This test will locate broken wires, and loose or dirty connections in the generator circuit.

1. Clip the test leads to two screwdrivers and use the screwdrivers as test probes.
2. Run the engine at about 1200 RPM, and turn on the headlights.
3. Set the function switch to the 0-3.2v position.
4. Measure the voltage between the ungrounded battery terminal and the B terminal of the regulator. This reading should be no more than .2v. If the reading is .2v or more, clean the terminals, and check for frayed wires. Measure the voltage between the ends of the thick wire from the generator to the regulator. Again, more than .2v means a dirty connection, or broken wire strands. Full battery voltage will indicate a completely broken wire.
5. Check the ground return of the generator. Measure the voltage between the frame of the generator to the grounded battery terminal. Be sure to contact the battery post and not the cable clamp. This reading should also be less than .2v. If the reading is higher, clean the battery terminals, and ground strap connection. Also tighten the generator mounting bolts.

M. Alternator system check.

This test will determine whether the alternator and regulator are functioning. It is advisable to consult the manufacturer's manual for information on your particular alternator system.

1. Connect the red clip to the battery (output) terminal of the alternator. Connect the black clip to the chassis. Set the function switch to the 0-16v position.
2. Switch on the headlights.
3. Start the engine and read the meter scale. With increased engine speed, the voltage should increase from battery voltage to about 15v. If the voltage remains at battery voltage, there is a problem in the alternator system. Due to the many various types of alternators, refer to the manufacturer's service data for information on your particular type.

N. Blown Fuses.

Suspected fuses may be quickly checked with the voltmeter, without removing the fuse from the holder.

1. Set the function switch in the 0-16v position.
2. Connect the red clip to one side of the fuse, and the black clip to the other.
3. Turn on the accessory that this fuse is used for. If the meter reads backwards, reverse the clip connections. If battery voltage appears on the meter, the fuse is burned out. If new fuses burn out when installed, check the accessory for short circuits to the chassis.

III. HOW TO USE THE AMMETER

A. Typical Hook-up

SEE FIGURE 3

1. Set the function switch to the CURRENT position.
2. Plug the black lead into the black receptacle. (It will fit only one way.)
3. A shunt bar is connected to one end of the black lead. The end marked (+) should always be connected to that part of the circuit going to the positive post (+) of the battery.

CAUTION: The shunt bar must not touch any other exposed metal when using the ammeter.

4. Disconnect a wire anywhere in the circuit to be tested and reconnect it to the circuit through the shunt. If you are unsure as to which end of the shunt to use, use either end and observe the meter when the circuit is turned on. If the meter reads downscale, simply reverse the connections on the shunt, by reversing the binding post assembly.
5. When the circuit is turned on, the meter will deflect and indicate the current flowing through the circuit in amperes. Read the green AMPERES scale as shown in Figure 3.

NOTE: Do not attempt to measure starter motor current with the shunt. Starter motor current greatly exceeds the 90 amp maximum of the meter.

B. Voltage Regulator Check.

In this section you will check the auto system's voltage and the ability of the regulator to keep the battery charged.

1. Warm up the regulator by running the engine for 15 minutes at about 1000 RPM with the headlights on.
2. Turn the engine and headlights off.
3. Plug the white and black test leads into the analyzer. These leads will fit only one way.
4. Set the function switch to the 0-16v position.
5. Disconnect the battery lead (BAT) from the regulator and reconnect through the ammeter shunt, with the positive end of the shunt (marked +) toward the regulator terminal. (On positive ground systems, reverse the shunt.)

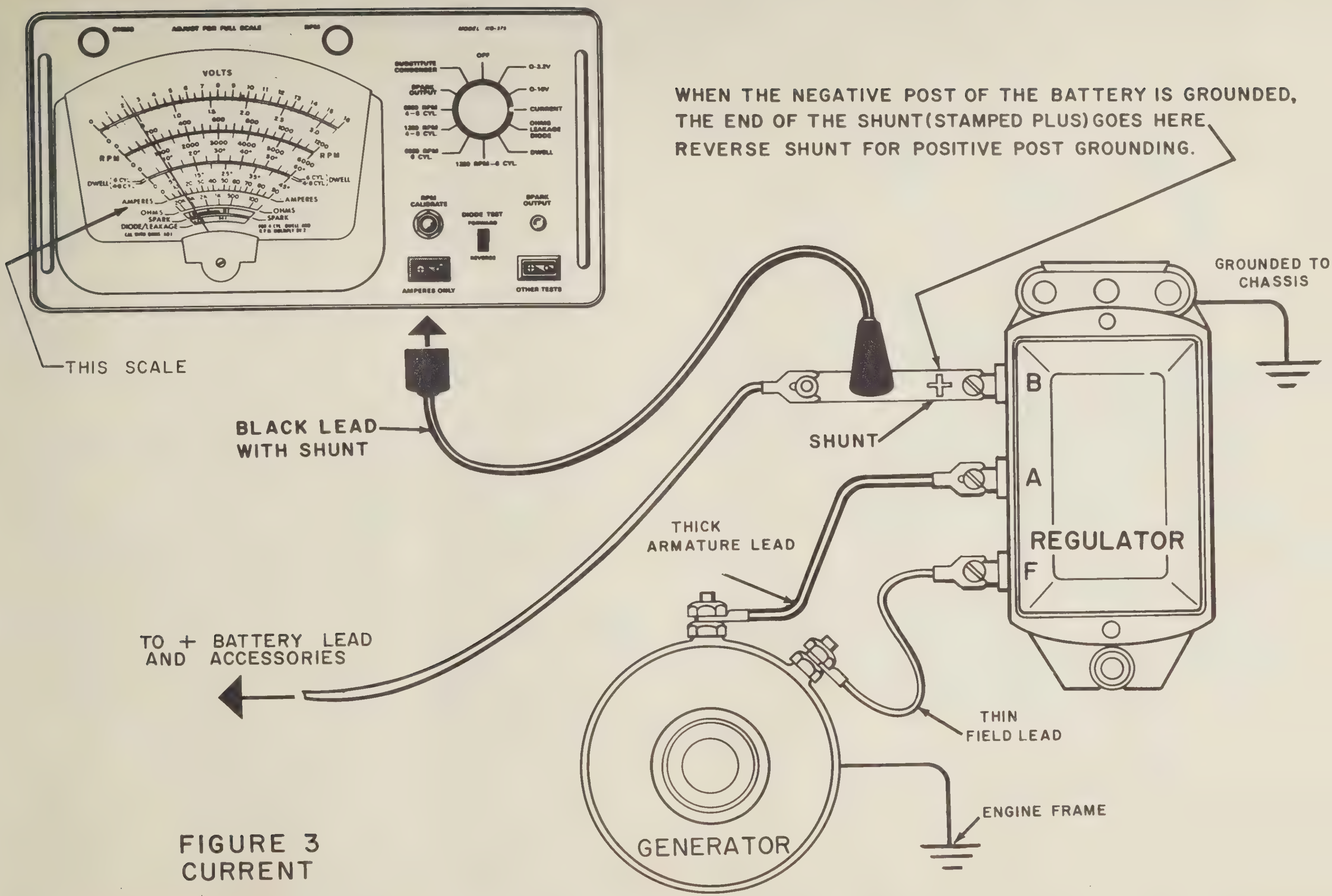


FIGURE 3
CURRENT

6. Attach the red clip lead to the battery terminal of the regulator and clip the black lead to ground. (Regulator base or car body.)
7. Polarize the generator. Before this can be done, you **must** know if your system is an EXTERNALLY GROUNDED SYSTEM or an INTERNALLY GROUNDED SYSTEM. If you are not sure, check your auto manual. Most automobiles with the exception of some Rambler-Nash-Hudson products and Ford Motor Company products have externally grounded systems. When you are sure of your system, do one of the following:

   EXTERNALLY GROUNDED SYSTEM
   Momentarily connect the battery terminal (BAT) of the regulator to the armature terminal (marked ARM or GEN) with a short jumper wire or screwdriver. This polarizes the generator.

   INTERNALLY GROUNDED SYSTEM
   Disconnect the field wire from the field terminal (FLD) of the regulator and momentarily touch it to the regulator battery terminal (BAT). This polarizes the generator. Reconnect the field wire to the field terminal of the regulator.
8. Start the engine and run it at about 1500 RPM. If the battery is fully charged, the meter should indicate about 14 to 15 volts. Set the function switch to the CURRENT position, the reading should be about 10 amps. If the battery is low, the voltmeter will read below 14 volts. If the current is well above 10 amps, let the engine run to see if the current drops down to about 10 amps. At this point the voltmeter should read 14-15 volts. If it doesn't the regulator is probably faulty.

NOTE: For 6 volt systems, the voltages mentioned above should be halved. Example: 15 volts changed to 7.5 volts.

C. Alternator output.

This test checks the current output of your alternator.

1. Connect the shunt between the battery terminal (output) of the alternator and the lead, with the + toward the alternator.

NOTE: If the meter reads backwards, reverse shunt connections.

2. Turn the function switch to the current position, and read the ampere scale on the meter.
3. Start the engine, run at slightly more than idle speed, and read the current on the amperes scale.
4. Consult the manufacturer's specifications for the correct charging current for your particular system.

IV. HOW TO USE THE DWELL ANGLE METER

A. Typical Hook-up

SEE FIGURE 4

1. Plug the white leads into the white receptacle; they will only fit one way.
2. Set the function switch to the DWELL position.
3. Connect the black clip to ground (connect the red clip for positive ground systems). Connect the other clip to the breaker point terminal or wire of the distributor.
4. Nudge the starter until the points close as indicated by the meter pointer moving to the right.
5. Rotate the OHMS adjust knob until the meter reads exactly full scale (60° on the 6 cyl. scale).
6. Start the engine and read the dwell angle on the proper scale. For a six cylinder engine, read the top dwell scale. For an eight cylinder engine, read the bottom scale. For four cylinder engines, read the eight cylinder scale, and multiply by two.
7. If the meter indicates a degree reading less than it should be, insufficient dwell is indicated. Decrease point gap to increase the dwell reading. If the meter indicates more than it should, excessive dwell is indicated, and the point gap should be made larger.

The angle or amount of dwell is determined by the distributor point spacing. The distributor cam opens the breaker points for each cylinder.

The cam is therefore divided into a number of lobes, one for each cylinder. One complete rotation of the distributor cam equals 360 degrees.

The 360 degrees of rotation is divided by the number of cylinders:

Six cylinders equals	60° per segement.
Eight cylinders	45°
Four cylinders	90°

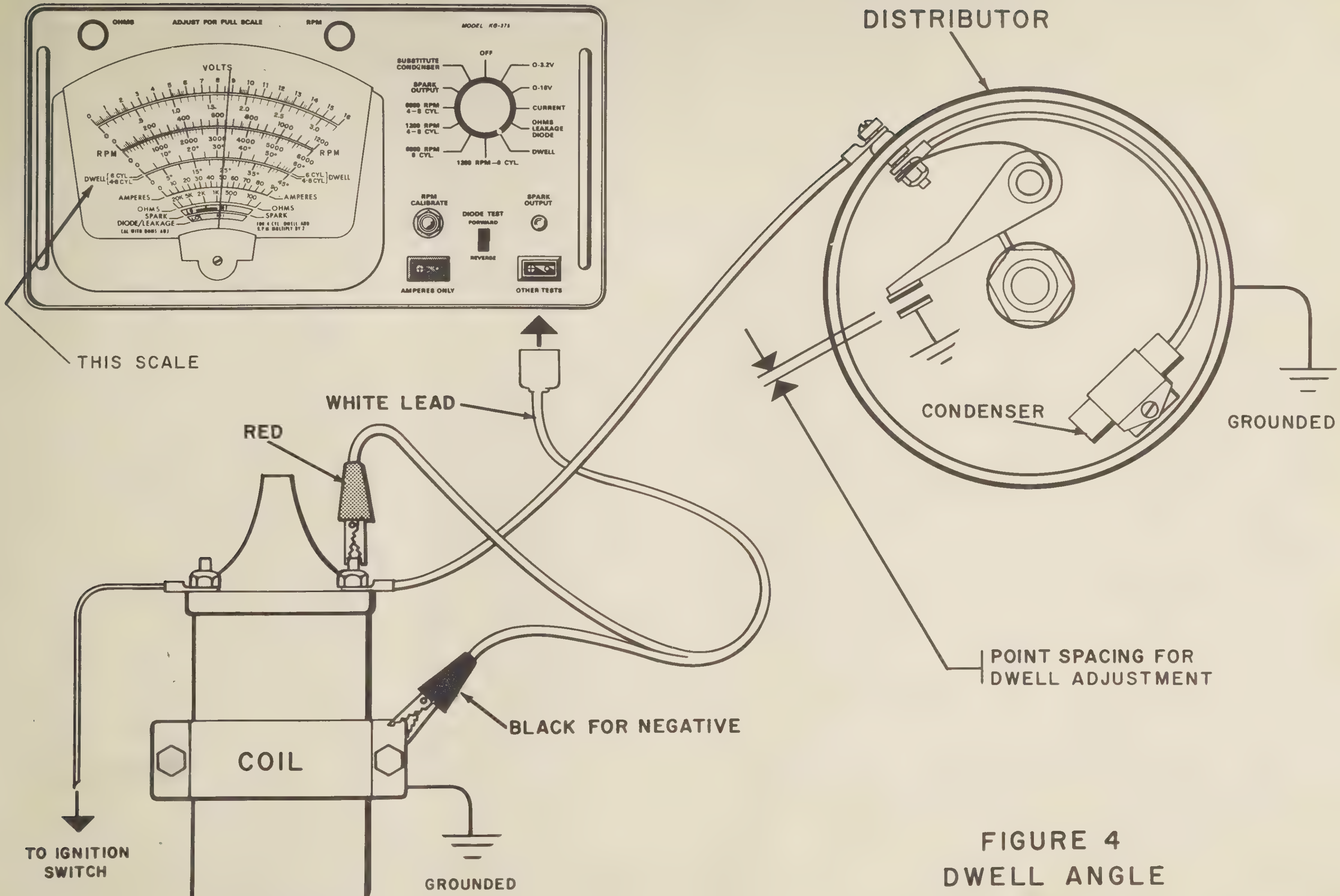


FIGURE 4
DWELL ANGLE

The points must remain closed for a certain period of cam rotation for the coil to produce a good spark. During this period the distributor cam will have rotated a certain number of degrees. The degree of cam rotation while the points remain closed is the DWELL OR CAM ANGLE.

Before checking dwell, carefully check the distributor and coil primary wiring to be sure that it is in good condition. Check to be sure that all of the spark plug leads are connected. Erratic readings will result if a lead is disconnected.

B. Distributor Wear.

1. Refer to the typical hook-up, Figure 4, and connect the analyzer accordingly.
2. Disconnect the vacuum line from the distributor and plug the open end.
3. Start the engine and observe the meter. Check the dwell reading at idle speed, and then slowly accelerate the engine to about 1500 RPM. The Dwell angle should not vary more than 2 or 3 degrees. Variation of more than this amount indicates wear in the distributor shaft or bearings, or the breaker plate.

NOTE: Variations in dwell above 1500 RPM is normal, and should not be interpreted as an indication of trouble.

4. Perform any necessary point adjustment. Unplug the vacuum line and reconnect to the distributor.

V. HOW TO USE THE TACHOMETER

A. Typical Hook-up.

SEE FIGURE 5

1. Plug the white lead into the white receptacle.
2. Rotate the function switch:
   a. To test a 4 or 8 cylinder engine at high speed, rotate the function switch to the $\frac{\text{6000 RPM}}{\text{4-8 cyl.}}$ position.
   b. To test a 4 or 8 cylinder engine at low speed, rotate the switch to the $\frac{\text{1200 RPM}}{\text{4-8 cyl.}}$ position.
   c. To test a 6 cylinder engine at high speed, rotate the switch to the $\frac{\text{6000 RPM}}{\text{6 cyl.}}$ position.
   d. To test a 6 cylinder engine at low speed, rotate the switch to the $\frac{\text{1200 RPM}}{\text{6 cyl.}}$ position.
3. Connect the black clip to the coil clamp.
4. Connect the remaining clip to the breaker point terminal or lead of the distributor. (Reverse clips for positive ground.)

5. With the engine running, press the red RPM CALIBRATE button and adjust the small RPM knob to make the needle point exactly to 6000 on the lower RPM scale.
6. Release the red button and read the RPM scale.

   With the function switch in either $\frac{\text{6000 RPM}}{\text{6 cyl.}}$ or $\frac{\text{6000 RPM}}{\text{4-8 cyl.}}$ position, read the bottom scale.

   For a 4 cylinder engine double the RPM reading on the 4 and 8 cycle scale.

   With the function switch in either $\frac{\text{1200 RPM}}{\text{6 cyl.}}$ or $\frac{\text{1200 RPM}}{\text{4-8 cyl.}}$ position, read the top scale.

   For a 4 cylinder engine double the RPM reading on the 4-8 cyl. scale.

NOTE: For maximum accuracy in the 6000 RPM ranges, the unit should be calibrated at or near 6000 RPM with a unit of known accuracy.

OR

Press the red RPM calibrate button and adjust the "RPM" knob for full scale before each reading.

B. Checking For Clogged Air Cleaner.

1. Warm up the engine.
2. Make sure the fast-slow idle cam on the carburetor is set for slow (or warm idle) with choke open.
3. Refer to TACHOMETER instructions and set the function switch to the 1200 RPM position.
4. Remove the air cleaner and make sure the choke is open.
5. Adjust throttle screw to 800 RPM.
   Watch the analyzer and replace the air cleaner.
6. If the RPM changes, clean or replace the air cleaner element.

C. Carburetor: Adjustment of Idle Mixture and Speed.

1. Follow the first 3 steps in section "B", "CHECKING FOR CLOGGED AIRCLEANER".
2. Adjust the spring-set idle mixture screw on the carburetor to the highest steady RPM reading.
3. On multiple barrel and dual carburetor engines adjust each mixture screw for maximum RPM.
4. Adjust the throttle screw to the factory recommended setting (425-550 RPM).

D. Power Balance Test.

In this test the engine will be divided into several pairs of cylinders (4 pairs for an eight cylinder engine) and run on each of these individual pairs. By comparing the speeds of the engine as it is run on each pair of cylinders, the general condition of the cylinders can be ascertained. An engine in good condition will run at about the same speed on each pair of cylinders.

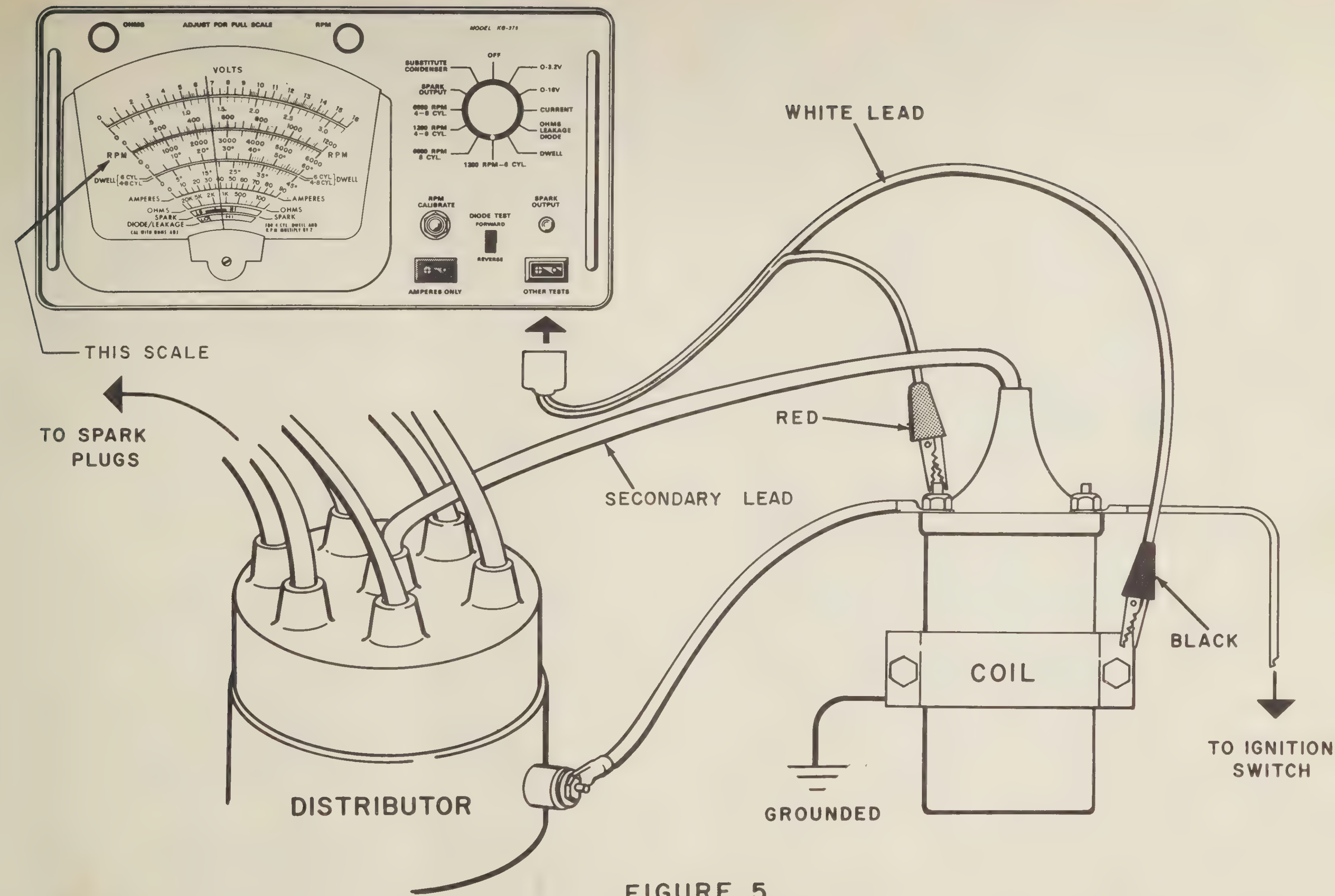


FIGURE 5
TACHOMETER

1. Refer to the TACHOMETER instructions and set the analyzer to the 1200 RPM position.

2. Attach the analyzer to the engine as explained in the TACHOMETER instructions.

3. This step is very important. DO NOT RUN YOUR ENGINE ON JUST ANY PAIR OF CYLINDERS OR YOU MAY SERIOUSLY DAMAGE THE ENGINE.

   In order to locate the proper pairs of cylinders, you will have to know your engine's firing order. Once this is known, divide the firing order in half and write the second half directly below the first half.

   Several vertical columns of numbers will be formed. Each vertical column contains the numbers of two cylinders which will safely run your engine.

   EXAMPLE: Chevrolet V8; Firing order 1-8-4-3-6-5-7-2

   Divide the firing order in half.

   1-8-4-3 6-5-7-2

   Write the second half below the first half.

   1-8-4-3

   6-5-7-2

   The vertical columns contain the proper pair of cylinders.

   1-6, 8-5, 4-7, 3-2

   This method can be used on all kinds of engines. A six cylinder engine will have 3 pairs of cylinders, a four cylinder 2 pairs.

4. With all the plug wires connected adjust the engine as follows:

   8 cylinder, Adjust to 1500 RPM with the idle speed screw.

   6 cylinder, Adjust to 1000 RPM.

   4 cylinder, Adjust to 900 RPM.

5. With the engine running **ground** all plug wires except the two you wish to run the engine on.

6. Note the Tachometer reading and record.

7. Do this with all the other pairs of cylinders and note the tachometer readings for each pair. A variation of more than 50 RPM indicates a faulty pair of cylinders. The pair which produces a reading lower than the others has a problem in one or both of the cylinders.

VI. HOW TO USE THE SPARK OUTPUT METER

A. Typical Hook-up.

SEE FIGURE 6

1. Plug the white lead into the white receptacle; it will fit only one way.

2. Rotate the function switch to the SPARK OUTPUT position.

3. Connect the red clip to any grounded bare metal part of the engine.

CAUTION: Failure to have this lead connected to ground creates a shock hazard.

4. Run the engine at approximately 850 RPM.

5. Touch the black clip to each spark plug terminal. If the plug terminals are insulated, use extensions or run a fine wire from the spark plug terminal under the insulation to the outside and touch the clip to the wire.

   Do not damage the rubber insulator or cable by piercing to make your connections.

   The plug being measured will not fire causing rough idle, but the meter needle should move to the right and the spark output lamp should flash. If the needle moves to the left of LO, ground the black clip and touch the plug with the red clip.

6. Read the SPARK scale on the meter. Normal spark readings should be the same for all plugs except where the spark plug leads are resistance wires for radio noise suppression. The longer the resistance wire is, the lower will be spark output through that wire.

   For transistorized ignition systems a spark output indication in the black or green area is normal. The SPARK scale is most useful when you have recorded the position of the needle for each plug in your car. Later, measurements can be compared in order to determine any change as a result of subsequent adjustments or the effects of normal wear.

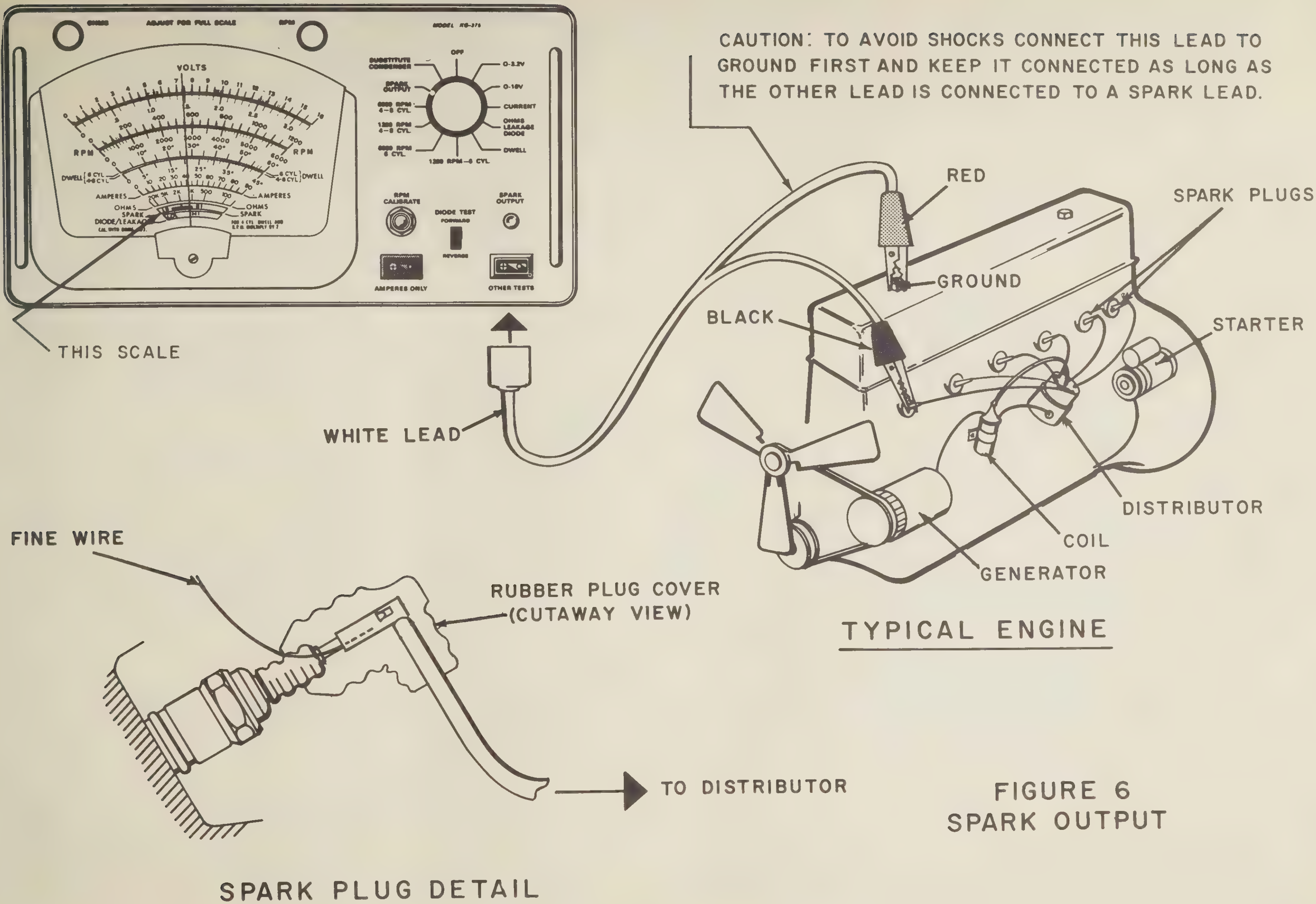


FIGURE 6
SPARK OUTPUT

B. Secondary Wiring.

This test will quickly locate shorted spark plugs, secondary ignition leads, or a faulty distributor cap.

1. Perform the SPARK OUTPUT TEST. If the needle deflects to the left of LO, reverse the two clip leads.
2. If the readings are excessively high at two or more plugs, those plugs may be getting voltage from the other plugs thru shorted leads or a shorted distributor cap.
3. If a plug gives no spark output, remove the lead at the plug and connect the black test clip to this end of the lead. If there is spark at this connection, a shorted plug is indicated. Clean or replace the plug.
4. If there is no spark at this lead in step 3, a short from ground to lead is indicated.
5. Weak spark on all plugs indicates high resistance in the coil primary circuit or a faulty distributor cap.

VII. HOW TO USE THE OHMMETER

A. Typical Hook-up.

SEE FIGURE 7

1. Plug the white lead into the white receptacle. It will only fit one way.

NOTE: Ohmmeter tests are of no value when there is voltage from an outside source applied to the circuit being measured.

2. Rotate the function knob to OHMS LEAKAGE DIODE position.
3. Short the two clips together and turn the OHMS adjustment knob until the needle points to 0 ohms on the OHMS scale (full scale).
4. Connect one clip to each of the terminals of the part or circuit to be checked and read the resistance on the green OHMS scale.

   If the needle does not move to the right, the circuit has infinite resistance indicating an open circuit. If the needle swings to the extreme right hand line, the resistance is very low, indicating a complete circuit, or short.

NOTE: 1 K on the scale is 1000 ohms
2 K is 2000 ohms, etc.

B. Coil Test.

Use this test to determine whether the coil windings are shorted or open.

1. Connect one clip lead to one of the primary coil terminals. Connect the other clip to the center terminal of the coil (use a screwdriver as a test probe if necessary).
2. Place the function switch in the OHMS-LEAKAGE-DIODE position, and read the meter scale. Partial meter deflection is normal. If the meter deflects full scale, the coil is shorted, and must be replaced. If you do not get a reading, connect the clip on the primary terminal to the other terminal. If the meter deflects now, the coil primary is open and the coil is defective. If the meter still does not deflect, the secondary is open, and the coil is defective.

C. Spark Lead Resistance.

Use this test to check for defective resistance type high tension leads.

1. Pull the suspected lead out of the distributor cap. Disconnect the other end from the sparkplug.
2. Connect a test clip to each end of the lead and read the resistance. The resistance should be about 4K (4000 ohms) per foot of length.

D. Short Circuits.

A short circuit is a condition where two conductors accidentally touch each other and allow current to flow around an intended load. A blown fuse usually indicates a short circuit. If a wire is suspected of being shorted to the car body or some adjacent wire, use the following test to check it:

1. Disconnect the wire from the current supply.
2. Disconnect the other end of the wire from the accessory, or in the case of a light, remove the bulb.
3. Connect one clip to the suspected wire. Connect the other clip to the car chassis or suspected adjacent wire. If a short exists, you will get a low resistance reading. No meter deflection indicates that a short circuit does not exist. When taking this reading, it is sometimes helpful to move adjacent wires. This will help to find intermittent short circuits.

E. Continuity Test.

The ohmmeter will also help determine whether a complete circuit exists. This test is useful when checking suspected fuses, lightbulbs, and wires.

1. Disconnect the suspected lamp, fuse, etc. from the circuit.
2. Connect the tests leads across the part to be tested. A low resistance (needle moves to right) reading indicates that the part is not "open". In the case of lamps, fuses, and wires, this indicates the part is good.

NOTE: A continuity test will not determine whether an electric motor is good or bad.

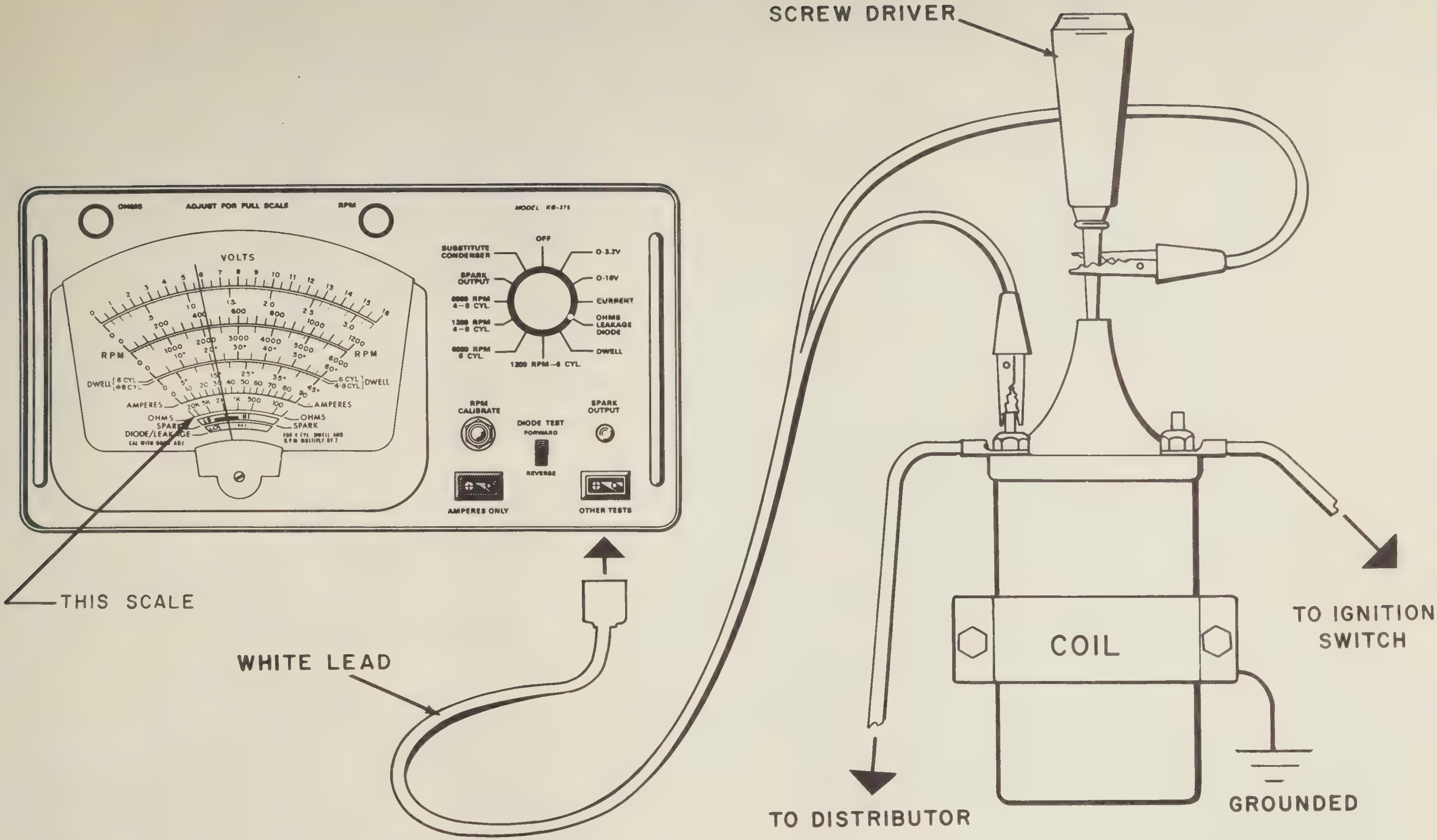


FIGURE 7
OHMMETER

VIII. HOW TO MEASURE CONDENSER LEAKAGE

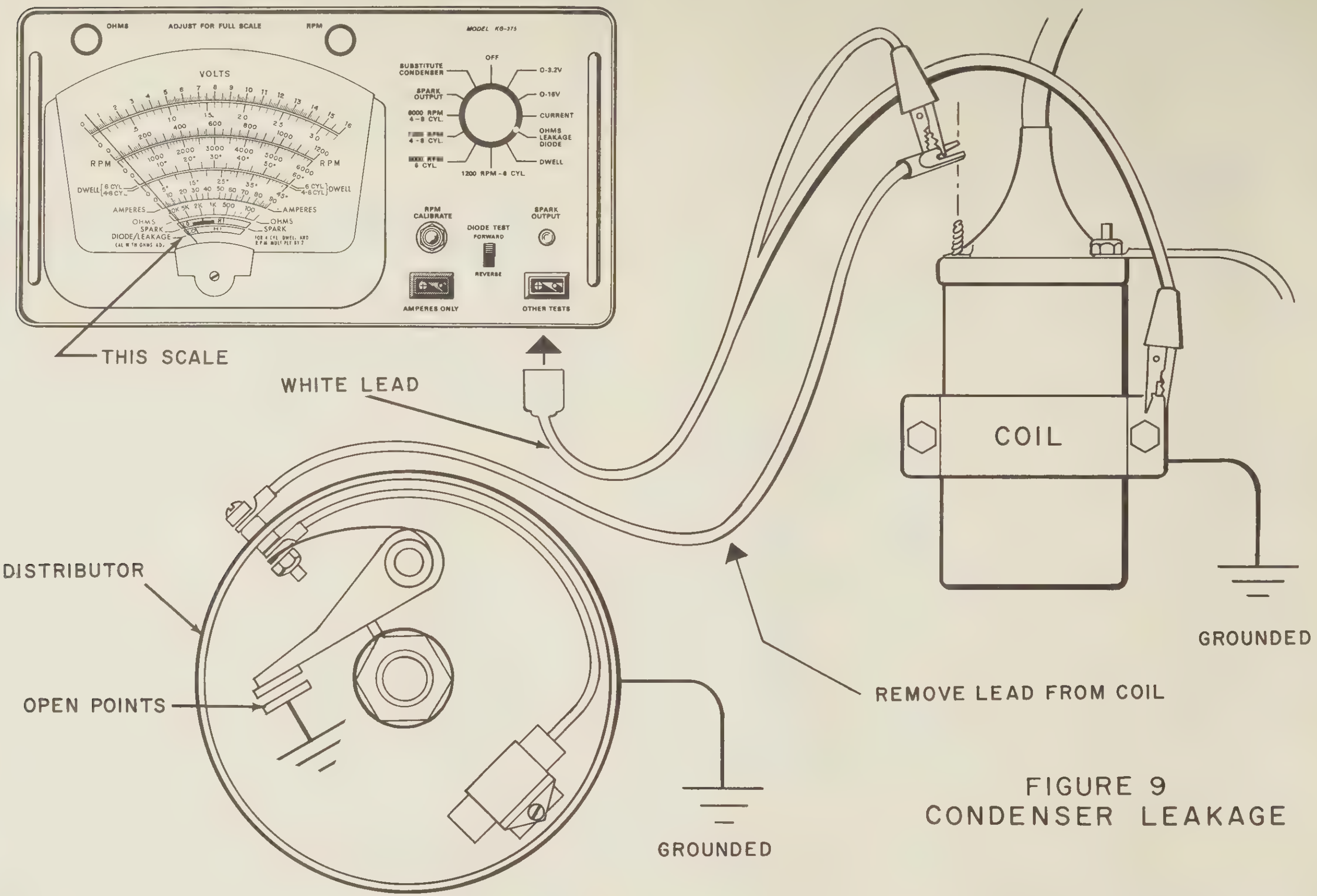


FIGURE 9
CONDENSER LEAKAGE

A. Typical Hook-up.

SEE FIGURE 9

1. Plug the white lead into the white receptacle.
2. Disconnect the distributor lead at the ignition coil.
3. Rotate the function knob to the OHMS-LEAKAGE-DIODE position.
4. Connect the two clips together and turn the OHMS adjustment knob until the needle points exactly to 0 ohms on the ohms scale (full scale).
5. Connect one of the clips to the distributor lead (removed from coil). Connect the other clip to the coil clamp.
6. Nudge the starter until the points open. When the points are open the needle should stay in the LO area of the DIODE LEAKAGE scale. If the needle stays anywhere in the HI area the condenser should be removed from the distributor and checked with one clip connected to the condenser lead and the other clip touching the condenser case.

If the meter still indicates HI leakage the condenser should be replaced. If, however, the condenser now checks in the LO area, carefully inspect the distributor wire for poor insulation. This wire sometimes "shorts" to the point breaker plate or distributor housing.

IX. HOW TO TEST DIODES

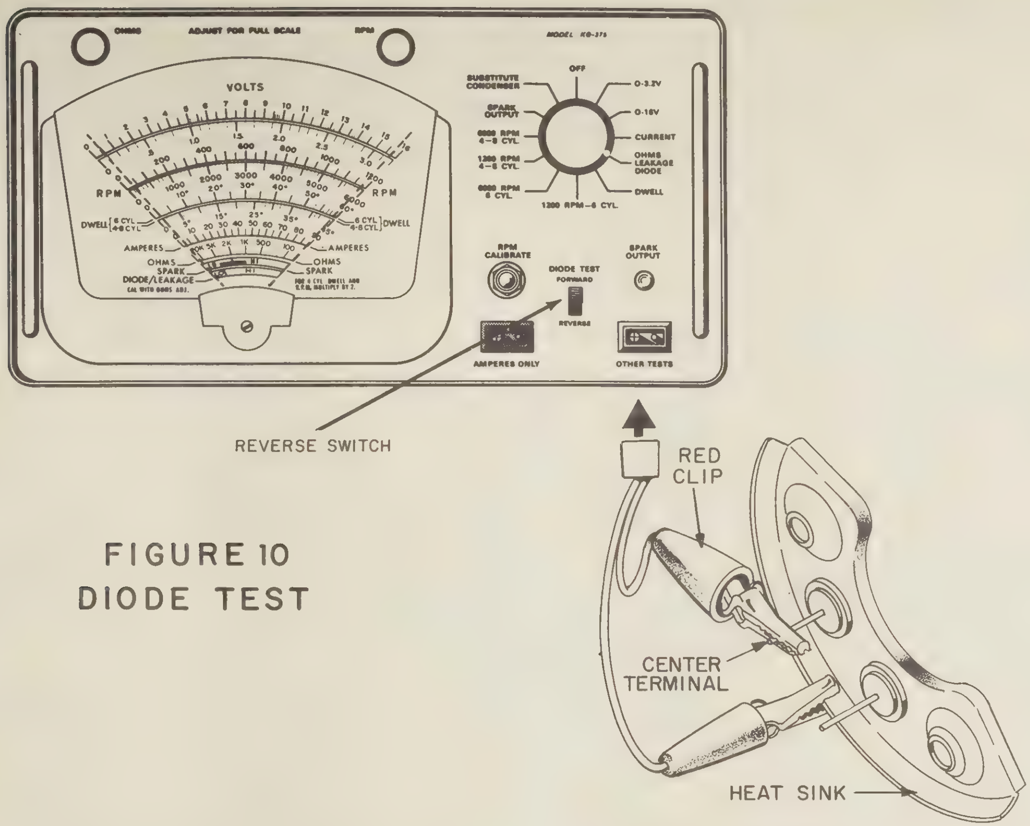


FIGURE 10
DIODE TEST

NOTE: Because of the necessity to disassemble the alternator to test the diodes, it is most convenient first to prove the alternator is defective. Check battery, regulator, wiring, output voltage and current before condemning the alternator.

A. Typical Hook-up.

SEE FIGURE 11

1. Plug the white lead into the white receptacle.
2. Rotate the function knob to OHMS-LEAKAGE-DIODE position.
3. Connect the two clips together and turn the OHMS adjustment knob until the needle points exactly to 0 ohms on the ohms scale.
4. Separate the diode end of the alternator case from the rest of the alternator to expose the diode leads. CAREFULLY disconnect the wire from a diode lead.
5. TO TEST: Connect one clip to the diode lead and the other clip to the diode case or heat sink. Observe the DIODE LEAKAGE scale. The needle should be either in the LO section or all the way to the right in the HI region. Now slide the DIODE TEST switch down and observe the meter. A good diode will cause the needle to swing to the opposite side of the meter. If the needle stays on the right side of the meter in both DIODE TEST switch positions, the diode is shorted. If the needle stays on the left side of the meter in both DIODE TEST switch positions, the diode is open. In either case the diode must be replaced with one of the same kind. There are both positive case and negative case diodes. The right kind must be used.

CAUTION: Be sure to reconnect the diode lead after it has been checked.

X. HOW TO USE THE SUBSTITUTE CONDENSER

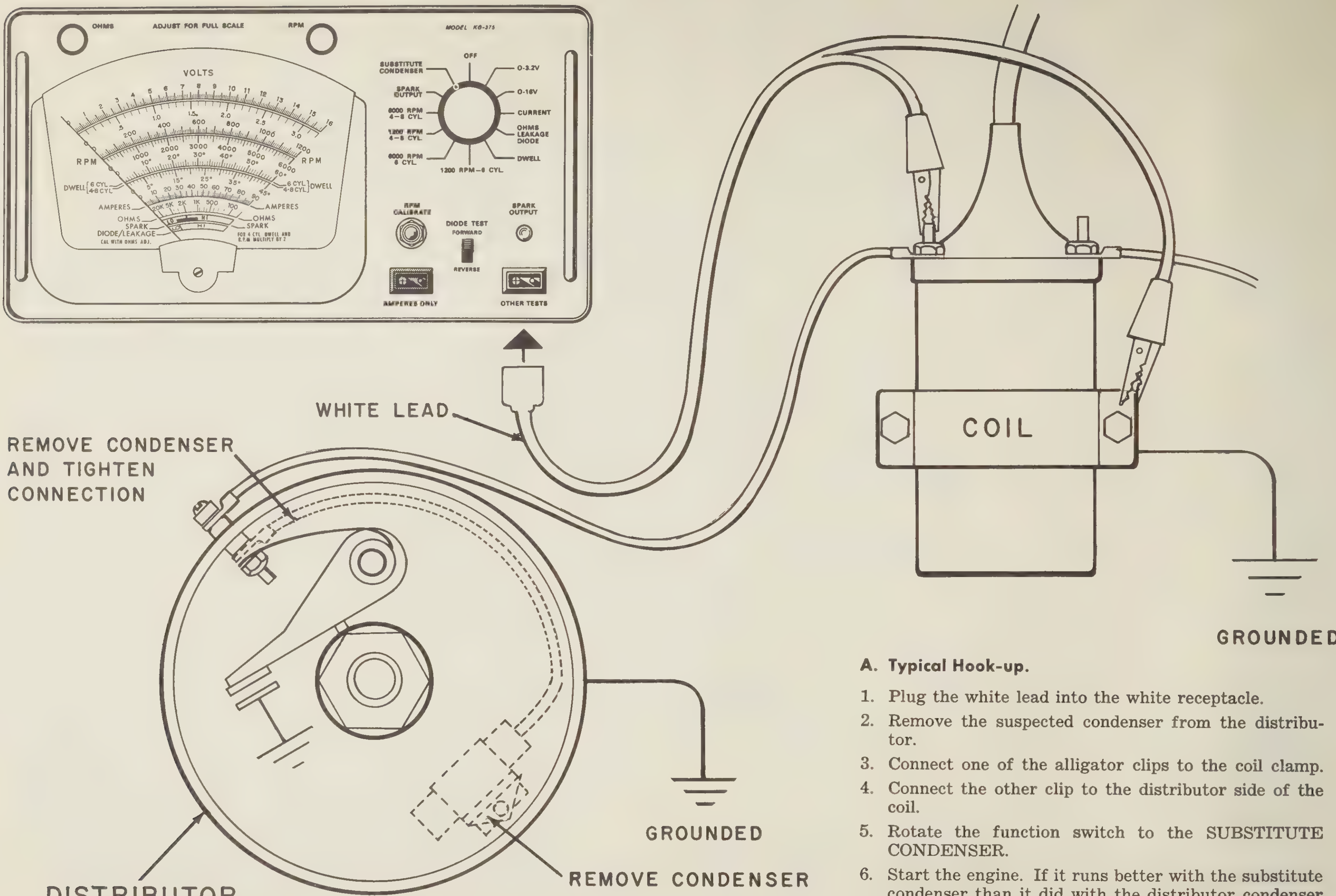


FIGURE 11
SUBSTITUTE CONDENSER

A. Typical Hook-up.

1. Plug the white lead into the white receptacle.
2. Remove the suspected condenser from the distributor.
3. Connect one of the alligator clips to the coil clamp.
4. Connect the other clip to the distributor side of the coil.
5. Rotate the function switch to the SUBSTITUTE CONDENSER.
6. Start the engine. If it runs better with the substitute condenser than it did with the distributor condenser connected, you may assume the distributor condenser is faulty.

TROUBLE SHOOTING CHART

Symptom	Possible Cause
HARD STARTING	I Carburetor A. Incorrect float setting. B. Gasoline starved C. Lack of vacuum from air leaks: intake manifold, accessory hoses, etc. D. Moisture or solid impurities in fuel line or carburetor. E. Carburetor flooded F. Defective choke or accelerator
	II Electrical: A. Battery: 1. Low charge 2. Loose or corroded terminals 3. Poor grounding strap
	B. Ignition 1. Primary circuit: a. High resistance dirty connections b. Faulty timing c. Broken wire or wire with defective insulation d. Leaky condenser e. Points improperly spaced f. Loose distributor terminal g. Ignition switch defective 2. Secondary circuit: a. Poor insulation on cables b. Cracked or dirty distributor cap

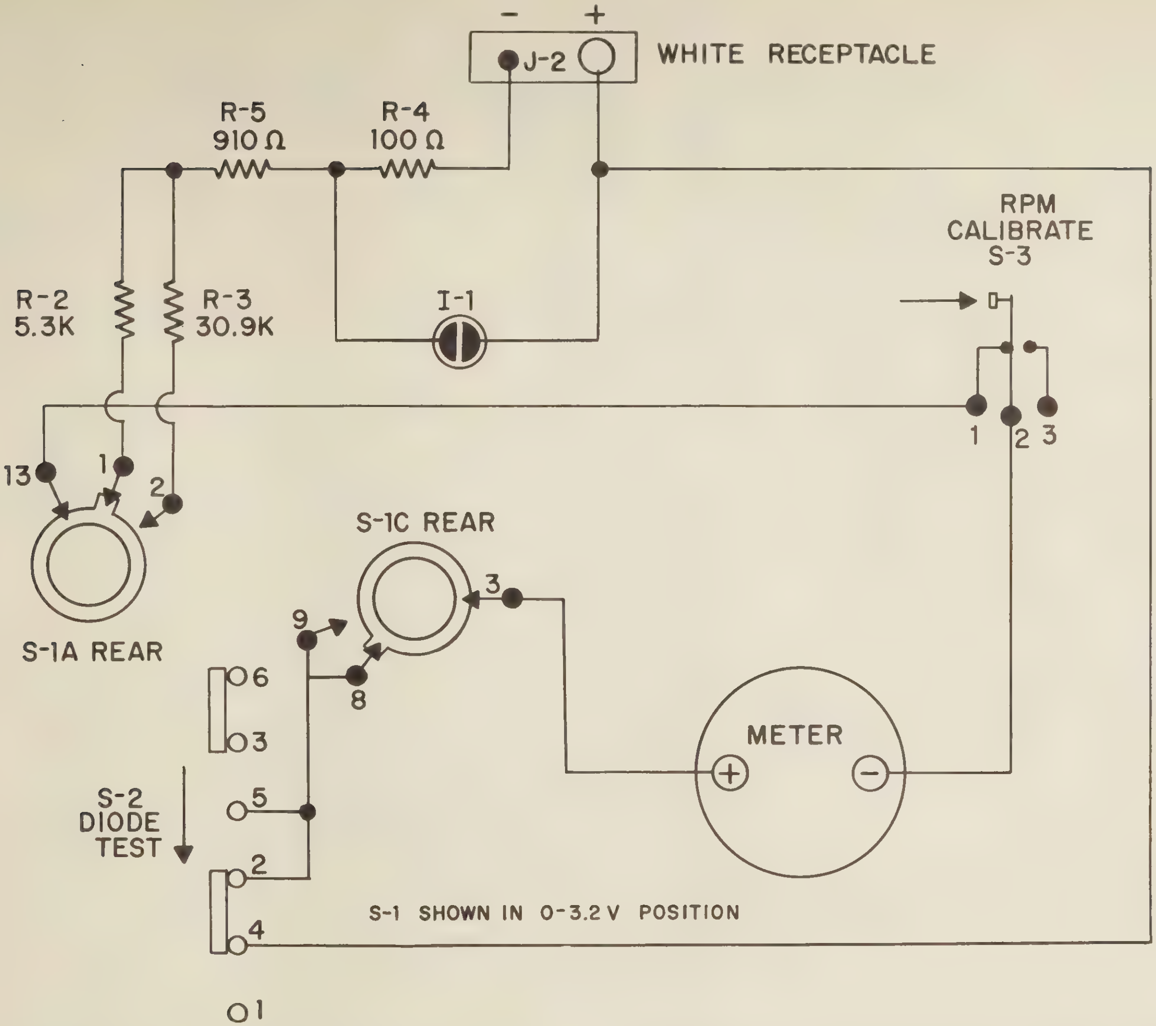
Symptom	Possible Cause
HARD STARTING (Continued)	c. Weak coil d. Defective spark plugs e. Plug cable in wrong firing order f. Rotor damaged or grounded g. Moisture inside distributor cap
	C. Starter Motor: (engine cranking speed slow with good battery) 1. Solenoid control circuit: a. Starter switch faulty b. Defective solenoid c. High resistance in solenoid wiring 2. Starter Motor: a. Shorted field b. Brushes worn c. Worn commutator d. Armature open
	III Poor Compression A. Loose or leaky head gasket B. Loose spark plugs C. Leaky valve seating, due to burned or worn valves and seats D. Weak or broken valve springs E. Overtightened tappets F. Worn or broken piston rings G. Cracked cylinder

TROUBLE SHOOTING CHART—Continued

Symptom	Possible Cause
POOR PERFORMANCE	1. Low Compression 2. Improper Spark Timing 3. Manifold Carburetor Heater Valve Stuck Closed 4. Faulty Carburetion 5. Throttle Linkage Loose 6. Restricted Air Filter 7. Faulty Accelerating Pump 8. Leaky Fuel Pump 9. Damaged or Plugged Exhaust System 10. Inefficient Cooling System 11. Knock or Ping 12. High Engine Friction: a. New parts b. Oil too heavy 13. Clutch Slippage 14. No Vacuum Spark Advance
SLOW SPEED MISFIRE	1. Carburetion: a. Float level too high or low b. Fuel jets worn or loose c. Dirty carburetor d. Vacuum leak in idle tube and/or throttle shaft 2. Vacuum Leaks: a. Leaky vacuum lines b. Crack in manifold gasket 3. Faulty Ignition Coil 4. Spark Plugs — Wrong Type or Defective 5. Compression Imbalance 6. Faulty Heat Control Valve 7. Leaky Head Gasket 8. Leaky Fuel Pump 9. Worn Valve Guides
KNOCK (PRE IGNITION)	1. Carbon or Other Glowing Material in Cylinder Head 2. Ignition Timing Advanced Too Much 3. Weak Spring in Centrifugal Spark Advance

Symptom	Possible Cause
KNOCK (PRE IGNITION) (Continued)	4. Vacuum Spark Advance Sticking 5. Spark Plugs: A. Heat rating too high B. Poreclain insulator or electrodes burned 6. Hot Valves — result of: A. Valve seats too narrow B. Too little tappet spacing C. Thin valve edges D. Intake and exhaust valves inchanged 7. Engine Overheating 8. Octane Rating of Fuel Too Low 9. Carburetion Too Lean 10. Manifold Heat Valve Stuck Shut
BACKFIRE THRU INTAKE	1. Spark Plugs With Wrong Spark Leads 2. Wrong Timing of Ignition or Valves 3. Intake Valves Not Closing Properly 4. Any Cause of Pre-ignition 5. Air-fuel Ratio Incorrect 6. Vacuum Leaks 7. Gasket Leaks Between Cylinders 8. Low Quality Fuel 9. Cracked Distributor Cap or Shorted Leads 10. Moisture Inside Distributor Cap 11. Centrifugal Distributor Advance Sticking
ENGINE OVERHEATING	1. Low Coolant Level 2. Fan Belt Loose, Glazed or Oil Soaked 3. Faulty Thermostat 4. Restricted Radiator Core 5. Incorrect Ignition Timing 6. Incorrect Valve Timing 7. Faulty Radiator Pressure Cap 8. Manifold Carburetor Heat Valve Stuck Shut

CIRCUIT DESCRIPTION



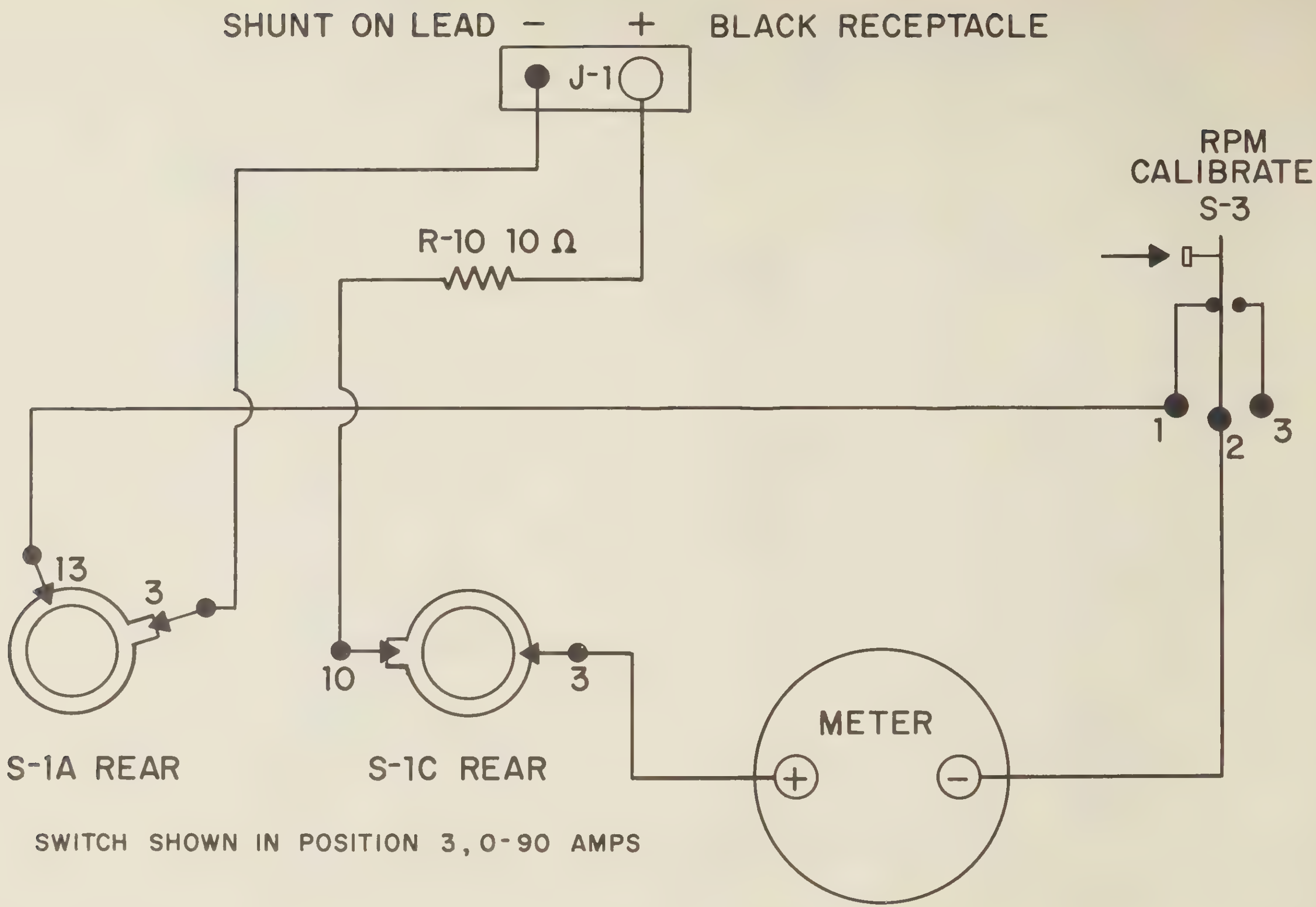
VOLTMETER

The DC voltmeter consists of a sensitive meter movement in series with some value of calibration resistor. The value of this calibration or dropping resistor determines the full scale reading of the meter.

Resistors R-2, R-4 and R-5 in series, are the calibration resistors for the 3.2 volt range of the meter. R-3, R-4 and R-5 are the resistors for the 16 volt range.

I-1, the neon bulb provides overload protection for the meter. In the event that high-voltage is accidentally connected to the meter test leads, this bulb will prevent the unit from being damaged.

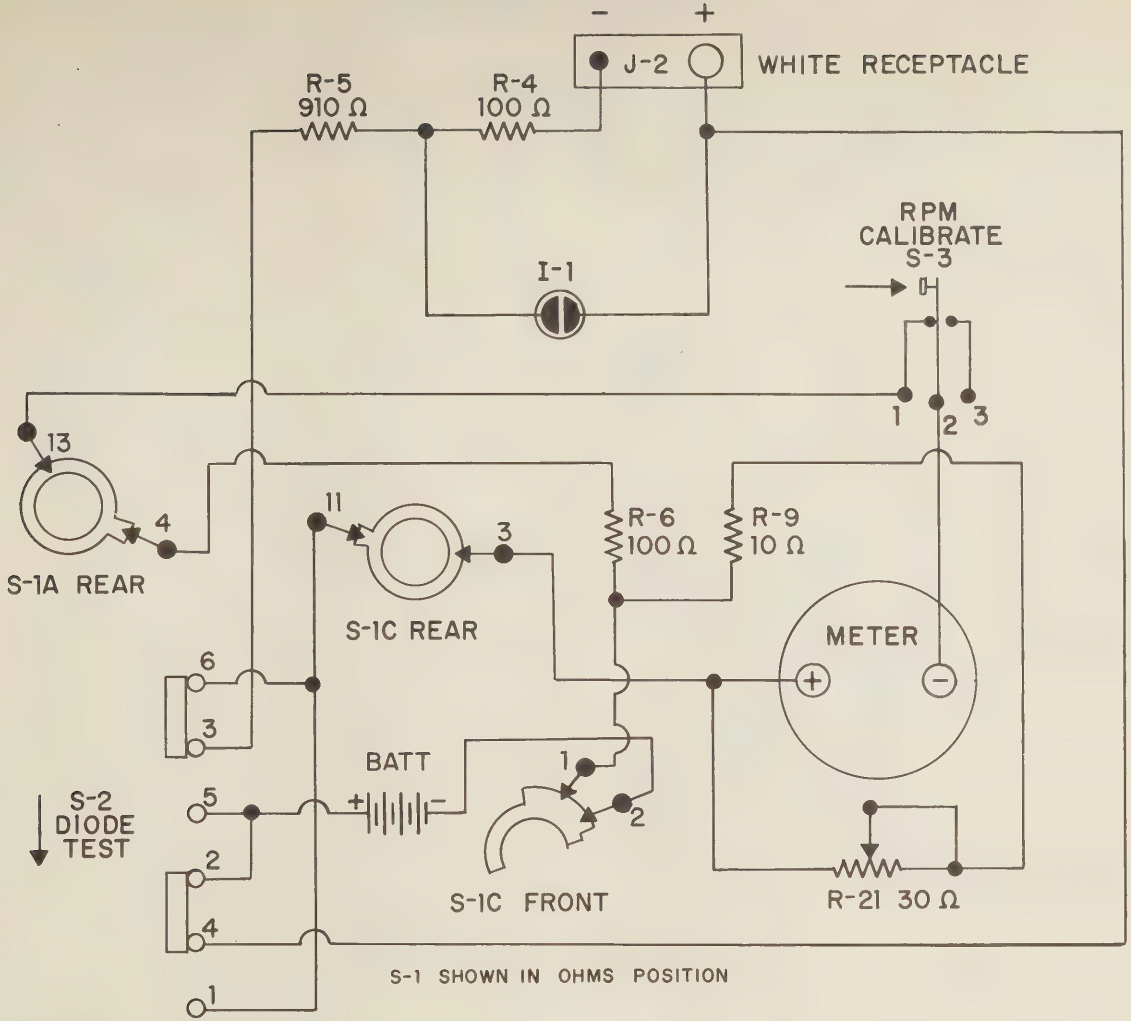
AMMETER



The DC ammeter is comprised basically of the shunt and the meter. The voltmeter is connected in such a way as to measure the voltage drop across the shunt. The resistance value of this shunt is a fixed value so the voltage drop across it is proportional to the current. The meter, while actually a voltage measuring device, has the ammeter scale calibrated to read the proportional amount of current which would result from the voltage drop across the shunt.

The full scale reading of the meter is determined by the meter resistance and the calibrating resistor R-10.

OHMMETER



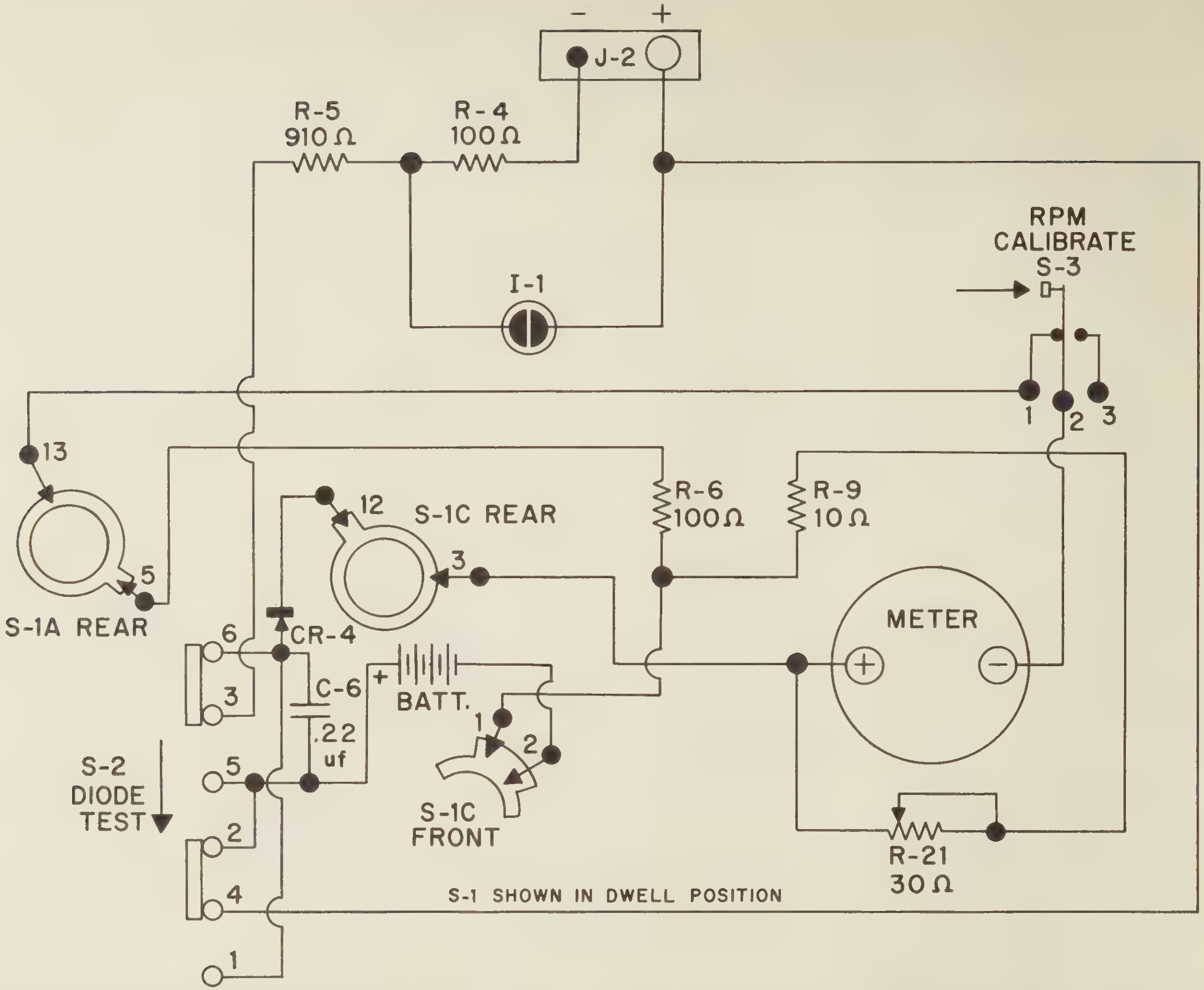
S-1 SHOWN IN OHMS POSITION

The ohmmeter consists of the meter, calibrating resistors and a voltage source in series. The voltage source for the ohmmeter circuit is the four batteries used in the unit. The voltmeter measures the voltage drop obtained when placing a resistance value across the test leads. The meter scale in this circuit is calibrated to read in ohms, the proportional amount of voltage drop across the resistor. This is accomplished by maintaining the voltage source at the same level.

To maintain a constant voltage at the source resistors R-6, R-20 and the Ohms Adjust control are used. By adjusting the Ohms Adjust control, compensation can be made for aging of the batteries.

The diode test switch is also a part of the ohmmeter circuit. It simply reverses the internal connections of the test leads to give a reverse resistance reading of diodes under test.

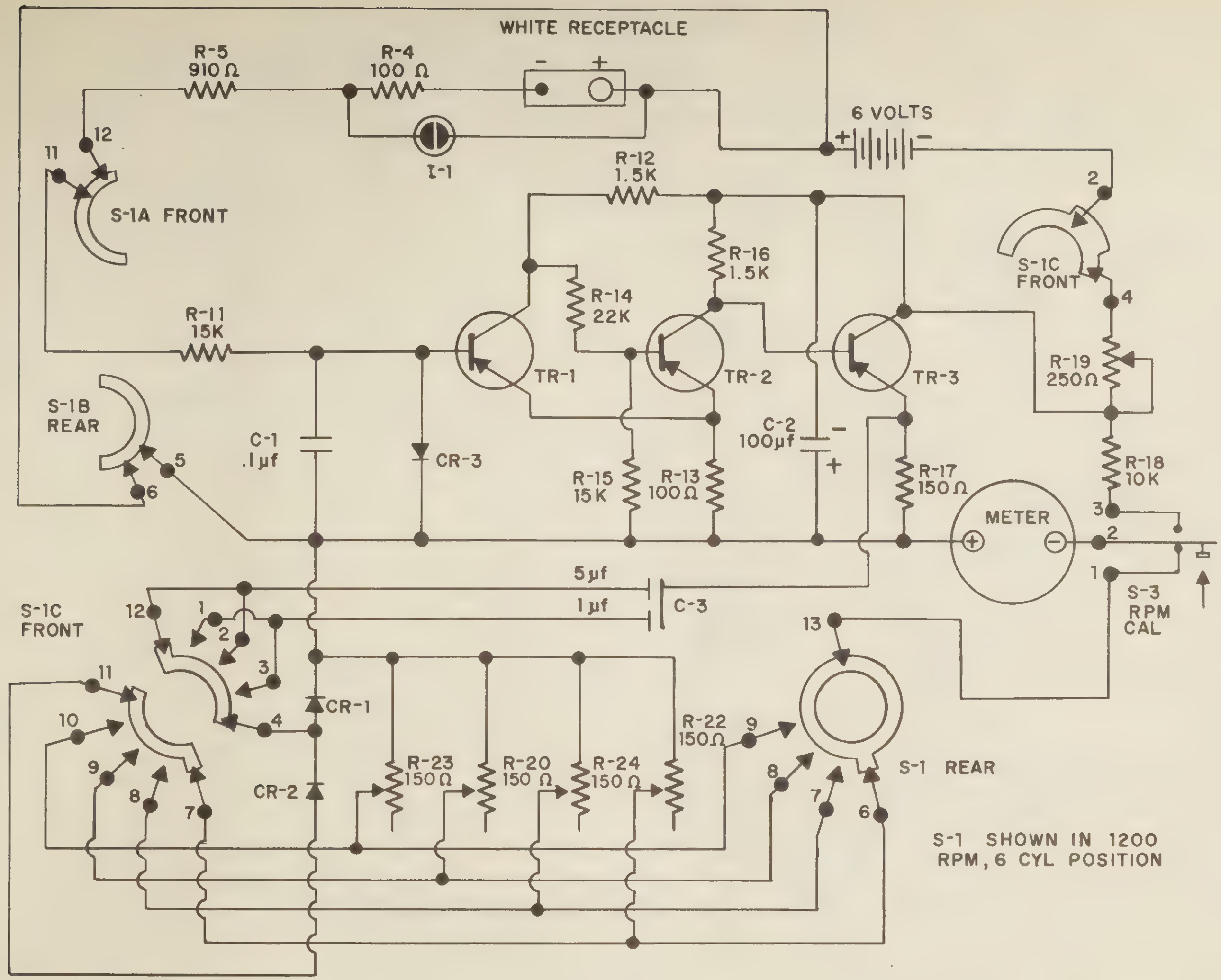
DWELL METER



The dwell meter is simply the ohmmeter, with a diode placed in-series with the calibrating resistor. A capacitor, C-6, is used to prevent high voltage surges from damaging the meter. Careful biasing of diode, CR-4, eliminates the possibility of the meter reading being affected by the car battery voltage passing through the ignition point contacts.

The meter measures the average degree of rotation that the points remain closed for each distributor cam segment, compared to the interval required for the distributor cam to make one complete rotation. The meter reading is thus proportional to the dwell or cam angle.

TACHOMETER



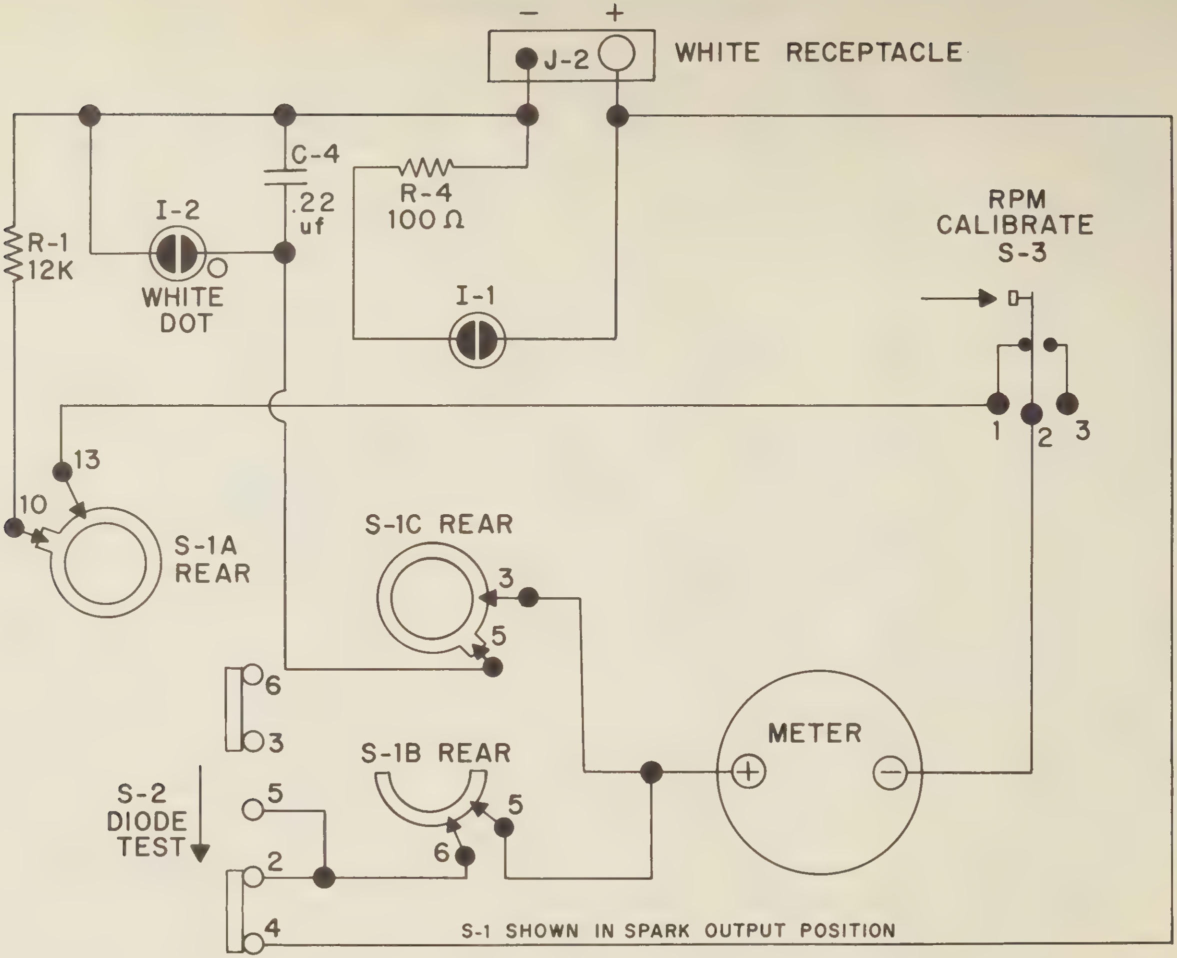
The tachometer is a pulse counting circuit which counts the number of pulses per unit of time. The number of pulses per unit of time is determined by the speed of the engine. These pulses are measured by the voltmeter and indicated on the revolutions per minute (RPM) scale of the meter.

These pulses are fed through a filter circuit composed of R-11 and C-1. These components remove any unwanted voltage interference from the pulses. This pulse is then applied to the square wave generator circuit comprised of TR-1, TR-2 and their associated components. The output of this generator circuit has constant amplitude. The frequency of the output is dependent on the number of pulses applied to the circuit.

Transistor TR-3 and components comprise an amplifier circuit which amplifies the square wave before applying to the pulse counting circuit. The pulse counting circuit consists of diodes CR-1, CR-2, CR-3 and the meter.

Diode CR-3 is used to prevent reverse pulses from damaging TR-1, the input transistor of the square wave generator.

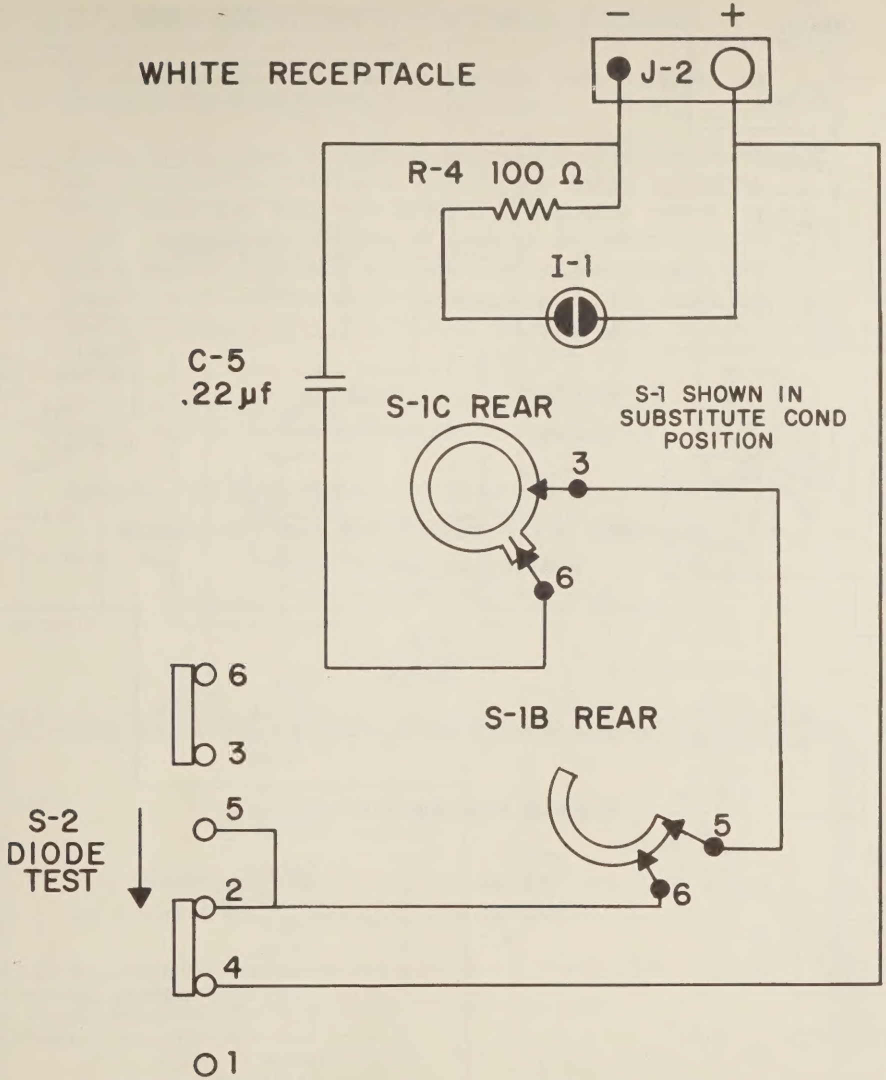
SPARK OUTPUT



The spark output circuit measures the average energy of the ignition sparks. This is accomplished by charging capacitor C-4 during the interval that the coil is supplying a spark to the engine. In the interval that no spark is delivered by the coil, the capacitor discharges through the meter. This discharge voltage will cause a meter reading. The Spark Output lamp on the front panel will also flash for each pulse to provide a visual indication. For automobiles using high-resistance type voltage cables or radio interference suppressors the Spark Output bulb may not light. This is not to be interpreted as an indication of trouble.

The resistor R-4 and I-1 the other pilot lamp are also used in this circuit as in all others as an overload protection for the meter.

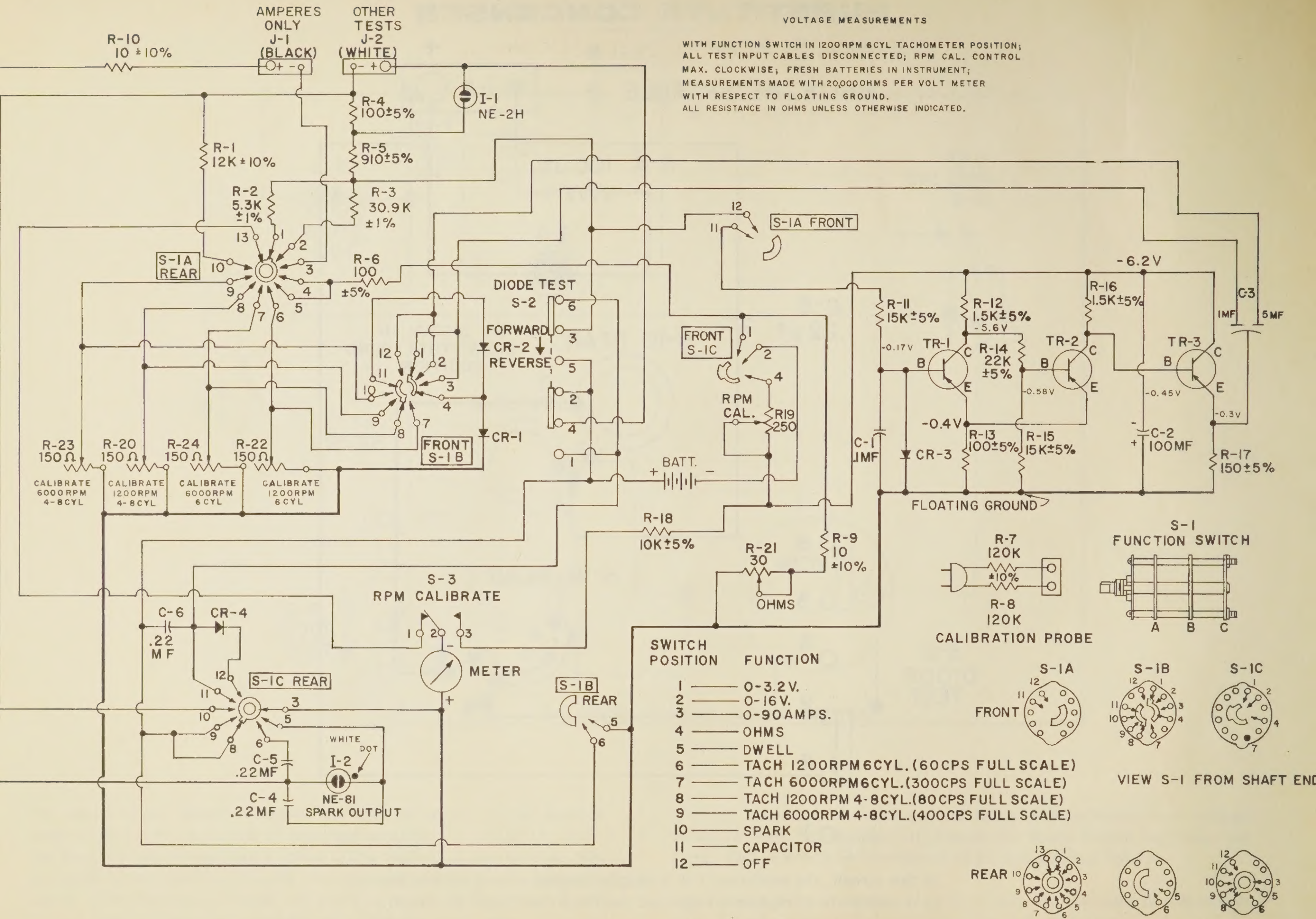
SUBSTITUTE CONDENSER



In this circuit, the condenser C-5 is simply shunted across the test leads as a substitute to replace a suspected defective distributor condenser.

VOLTAGE MEASUREMENTS

WITH FUNCTION SWITCH IN 1200 RPM 6CYL TACHOMETER POSITION; ALL TEST INPUT CABLES DISCONNECTED; RPM CAL. CONTROL MAX. CLOCKWISE; FRESH BATTERIES IN INSTRUMENT; MEASUREMENTS MADE WITH 20,000 OHMS PER VOLT METER WITH RESPECT TO FLOATING GROUND.
ALL RESISTANCE IN OHMS UNLESS OTHERWISE INDICATED.



SWITCH POSITION	FUNCTION
1	0-3.2V.
2	0-16V.
3	0-90AMPS.
4	OHMS
5	DWELL
6	TACH 1200RPM6CYL.(60CPS FULL SCALE)
7	TACH 6000RPM6CYL.(300CPS FULL SCALE)
8	TACH 1200RPM 4-8CYL.(80CPS FULL SCALE)
9	TACH 6000RPM 4-8CYL.(400CPS FULL SCALE)
10	SPARK
11	CAPACITOR
12	OFF

IMPORTANT INSTRUCTIONS

If your unit is not operating properly, first write to our Technical Consulting Service for assistance.

Authorization must be obtained before returning your equipment for service. After you receive your return authorization, please pack your unit in a sturdy shipping carton and tightly cushion with plenty of packing material to avoid costly damage in transit. Send the package prepaid and fully insured to the address at the bottom of this page. Mark the package: FRAGILE — DELICATE ELECTRONIC EQUIPMENT.

If service is required after this warranty period, an estimate will be sent to you before repairs are made.

ADDRESS CORRESPONDENCE AND RETURNED EQUIPMENT TO:

KNIGHT ELECTRONICS CORP.

Knight Service Department

2100 Maywood Drive • Maywood, Illinois

KNIGHT WARRANTY

Your Knight equipment is warranted to be free from defects for a period of one year under normal use.

Any defective parts will be repaired or replaced free of charge during the first ninety days from date of sale.

After ninety days, and for the balance of the year, we will replace any defective parts, charging only for labor.